

# THE IMPERIAL QUICKSILVER WORKS AT IDRIA, KRAIN.

---

ISSUED BY THE MINING DIRECTORY AT IDRIA, IN CELEBRATION OF THE  
THREE HUNDREDTH ANNIVERSARY OF THE EXCLUSIVE  
MANAGEMENT OF THE MINES BY THE  
AUSTRIAN GOVERNMENT.

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VIENNA, 1884.

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TRANSLATED BY  
SAMUEL B. CHRISTY,  
INSTRUCTOR OF MINING AND METALLURGY, UNIVERSITY OF CALIFORNIA.

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PUBLISHED BY J. B. RANDOL,  
1884.

*With the Compliments of*

Samuel B. Christy,

*Berkeley, California.*

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ALBION  
VIA RAIL STATE

## TRANSLATOR'S PREFACE.

At about the time of the discovery of America quicksilver was first found at Idria, and the deposit has been worked almost continuously ever since. Next to the mine of Almaden, in Spain, it has produced the greater part of the quicksilver used by the entire world for the last four centuries. Next to Almaden, in Spain, and New Almaden, in California, it has still the largest annual quicksilver product of any mine in the world. These facts alone give considerable interest to any account of the Idria mine. It now has been for over three centuries under the control of the Austrian Government, and may be said to have witnessed from their very infancy the complete rise and progress of the arts of mining and quicksilver reduction. The mining and metallurgical works, as they now exist, may be taken to show the high state of general efficiency to which such a large industry may be carried under Government control. At the same time the whole plan of organization and the relations of the management with miners and workmen are almost directly opposed to what is usual in England and America. A comparison of the paternal and the commercial methods of managing mining interests would be very interesting, but must be reserved for some other occasion.

The brochure of which this is a translation is a souvenir of the three hundredth anniversary of the management of the mine by the Austrian Government. It was issued by the Mining Directory, and is the joint production of its members.

The present translation has been made in view not only of the interest and importance of the subjects treated, but also on account of the able manner in which they have been handled.

Throughout the weights and measures have been given in the metric system, as in the original, on account of the manifold advantages

of that system over our own. The values in florins have been also retained. For convenience in converting them into American weights, measures and values, a table of equivalents is given on p. viii.

The appendix to the original memoir on the "Celebration of the three hundredth anniversary, held June 21, 22 and 23, 1880," written by Josef Cermak, K. K. Bergrath, has not been translated. However, a brief notice of it should not be omitted, as it gives a most graceful picture of the old mining town of Idria in festive garb.

The celebration began on the eve of the day of St. Achatius (Patron Saint of the Mine), and was opened at the mine theatre by a dramatic prologue, with a series of poetic pictures and tableaux, which gave a history of the mine from the time its treasures were guarded by gnomes and Kobalds to the realism of the present, where the scene closed with a richly-decorated picture of the Emperor surrounded by a group of miners, and a view of the present town of Idria with its shaft works and chimneys, and was followed by uproarious "Glück aufs" to the Emperor and Empress and a chorus of Volkhymns by the miners. A short comedy came next and an illumination of the town and a general good time followed.

The next day, 22d June, 1880, was filled with processions, music, speeches and a grand banquet, in which the officials of the mine, of the Ministry of Agriculture and many others participated. The Minister of Agriculture announced the decree of the Emperor, conferring the title of Hofrath upon Ober-Bergrath M. V. Lipold, and the decoration of the Ritter Kreuz of the Order of Franz Josef was conferred upon Bergrath J. Cermak.

The third day was occupied by a tour through the mine and works by the visitors and guests. A telegram from the Director of the Cabinet was received at dinner, announcing the thanks of His Majesty the Emperor for the loyal devotion of the mining people of Idria, and expressing his good wishes for the continued prosperity of the ancient town.

The festivities were closed by an "Abschieds Commers," at which the toast of "The Ladies, the Patrons of the Quicksilver Industry," was ingeniously brought in, on the ground of their devotion to the use of mirrors.

In conclusion, it should be stated that the present publication is due to Mr. J. B. Randol, Manager of the New Almaden mine, and is a recognition on his part of the courtesies he received at the hands of the Mining Directory at the time of his visit to Idria in 1880.

UNIVERSITY OF CALIFORNIA, BERKELEY, May 20, 1884.

## TABLE OF EQUIVALENTS.

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1 Austrian Gulden or Florin = 39.8 cents U. S. gold coin, Custom House value.

For approximations 40 cents may be taken.

1 Metre = 3.2809 U. S. feet = 10 d. m. = 100 = c. m. = 1000 m. m.

1 Sq. metre = 10.7643 sq. ft. Eng. and U. S.

1 Cu. metre = 35.3165 cu. ft. Eng. and U. S.

1 Are = 100 sq. metres.

1 Hektare = 100 ares.

1 Litre = 1 cubic decimetre =  $\frac{1}{1000}$  cu. metre.

1 Hektolitre = 100 litres =  $\frac{1}{10}$  cu. metre.

1 Kilogramme = 1000 grm = 2.2046 lbs. Ad.

1 Metric centner = 220.46 lbs., say 220½ lbs.

Roughly, a metric centner is very nearly  $\frac{1}{10}$  long ton of 2240 lbs.

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## I.

### Historical Introduction.

*By M. V. Lipold, Imperial Court Counselor and Chief of the Mining Directory at Idria.*

The occurrence of quicksilver at Idria was noticed in the year 1490, according to others in 1497. The discovery was made by a cooper, who manufactured wooden utensils in the then thickly wooded vicinity. He found, after some time, drops of quicksilver in a tub which he had placed under a spring, near the present Holy Trinity Church. After he was enlightened in the neighboring city, Bishoflak, as to the value of his discovery, he shared it with a peasant named Cancian Anderle, and formed with him and some others a company for opening the ore deposit.

This company sold its claim in 1504 to a mining company which undertook the mining very energetically, and later received the name of "Mining Co. of St. Achazi."

In the year 1509 the reigning prince, Emperor Maximilian I., allowed a mine, the "Prince's Mine," to be opened at Idria on his own account.

In 1509 the Venetians invaded Idria and took possession of the mines; but in the next year—1510—the Venetians were driven out by the Imperial troops, and Emperor Maximilian I. granted the mines occupied by them to the "Mining Co. of St. Achazi," from Feb. 25th, 1510. This grant was confirmed by the Archduke Charles, March 2d, 1521.

The fear of hostile invasion gave the miners occasion to build the strong castle, "Gewerkenegg," the present business building. It was begun in 1520 and finished in 1531.

A second company, called "St. Catherine's Shaft," originated in 1520 and, also, the reigning prince, Emperor Ferdinand I., allowed a new mine, the "George Shaft," to be opened in 1523.

Great danger threatened the mines in 1525, for by the fall of a land slide on the eastern slope of the Kobolova planina, the Idriza river was dammed up till it nearly reached the mines.

The caving in of the mine in 1532 cost the lives of many miners. The place of the accident is known as "Dead Hole" to this day.

The mining companies, which for some considerable time had held their ground, fell gradually more and more behind. The mines, which had already reached to half the depth of the present workings, became constantly more expensive, and they suffered losses in the quicksilver traffic, which from time to time ceased. This compelled them to accept advances from the reigning prince; also in the payment of duty they remained behind hand. The mines were therefore laden with debts when the son of Emperor Ferdinand I., Archduke Charles, undertook the management of inner Austria, County Görz, and the reigning prince's share of the quicksilver mines of Idria.

This prince came to the conclusion that the miners could not be really helped by advances of money, and that the expense and irregularity of the mining was mostly due to its being split up among various companies. He determined, therefore, to place the entire mining operations at Idria under Imperial direction, in order that it might be conducted in a rational and uniform manner. In the year 1575 he conducted, through Franz Khisel, the Mining Judge of Obervellach, the necessary transactions with the miners for purchasing the mines. These transactions were completed in the year 1578, so that in the following year the prince took possession of all the various mines, with their belongings; and already, in the year 1580, the mining operations at Idria were undertaken in the name of the prince and under the direction of his officers.

The assumption of the quicksilver mine as the sole property of the prince was announced in the "Neu aufgerichteten Ordnung für das Perckwerch Idria," which Archduke Charles published April 6th, 1580, in Graz. By this "Carolinian Mining Regulation for Idria," the reservation of quicksilver mining was established. This regulation still exists, and prevents all private individuals from mining in the former dominion of Idria.

In commemoration of the now more than three-hundredth anniversary of the sole possession of the mines of Idria by the government, and the third centenary of its exclusive administration of the mines, this memoir has been written.

In 1607 Archduke Ferdinand II. separated Idria from Tolmein and dedicated it to mining work. By this dedication and the combination of an extensive land possession, mostly wooded, with the mining property, the latter was secured by the possession of timber, fuel, and water power. The mine became at the same time a land owner, and was made self-sustaining.

Also the civil jurisdiction devolved upon Idria, and only the criminal jurisdiction was reserved for the district of Tolmein.

The domain of Idria occupied till the end of the last century a peculiar position. The mining management was under the direct protection of the prince, except in criminal matters, which came under the jurisdiction of Tolmein in the County Görz. In the year 1783, the domain of Idria was transferred to Krain, and has formed since a constituent part of that dukedom. However, the direction of the mining was never under the Land Bureau, but either indirectly through a mining director, or as at present, directly under the Imperial Office at Vienna.

Among the general historical events, the following deserve mention here:

At the time of the French war the French possessed Idria, first from 1797 to 1798, and again for two months in 1805. Through the establishment of the kingdom of Illyria by the Emperor Napoleon in 1809, Idria again came into the possession of the French, in which it remained till October 1st, 1813, when it was again taken by Austria.

On March 15th, 1803, a fire started in the mine at Clementifeld, and to extinguish it the mine had to be drowned out. The drainage of the mine took three years.

On May 16th, 1816, his Majesty, Emperor Franz I., and on August 16th, 1819, his Royal Highness, Crown Prince Ferdinand, honored the mine with a visit.

On September 30th, 1837, a water break occurred in the deepest

part of the Theresa shaft, which drowned out the deeper levels of the mine. The first steam engine was built near this shaft for pumping out the water, and the sump of the shaft was dammed.

On November 3d, 1846, a mine fire began in Hauptmannsfeld, by which one officer, three foremen and thirteen miners were sacrificed, and which also could only be extinguished by drowning out the mine.

Very unfortunate circumstances occurred in the middle of the last century and in the first twenty years of this century. At both these periods it was thought that the mine was exhausted—during the middle of the former century, owing to a lack of sufficient prospecting, and in this century in consequence of working only the rich ore, forced by the Spanish contract for delivering quicksilver which began with the end of the last century; also in consequence of intermission of prospecting during and after the French occupation. In both cases the mining was regulated again by State Commissioners, and brought into a flourishing condition. In the middle of the previous century it was Mining Counselor Anton Hauptman, and in the year 1823 Governmental Counselor Josef Stadler, to whom the mining was indebted for its continuance and further secured development.

In the year 1865 the Idria mine ought to have been given up to private industry like many other State mines, but it did not come to the sale. Since the year 1867 the work has made important progress. In the last thirteen years, from 1867 to 1879 inclusive, the production has increased more than half, and the clear gain amounted altogether to 9,626,000 gulden (~~\$4,813,000~~) (\$3,831,148).

## II.

### Ore Deposits.

*By M. V. Lipold.*

Formerly the rocks in which the ore deposits of Idria occur were considered much older than they are. The reason for this supposition was the existence of an old clay slate which occurred in the northwestern part of the mine, in the hanging wall of the ore-bearing strata, and which was designated by the name of "silver slate" (Silberschiefer). This clay slate, widely spread in Krain, was known to belong to the Carboniferous Formation (Gailthaler strata); they thought, therefore, that the underlying ore-bearing dolomite, conglomerate, slate, etc., were likewise Carboniferous or a still older formation.

The consideration of the geological details of the neighborhood of Idria in the years 1867 to 1873 by the author of this chapter,\* furnished for the first time safe and certain starting points for the determination of the age of the ore-bearing strata of the Idria mines.

In the closing remarks of this article, p. 454, etc., it was stated that in the ore-bearing rocks of the mine considerable remains even of fossils and plants were found, which determined beyond a doubt that the peculiar ore-bearing rocks of the quicksilver mines belonged to the Triassic formation, and indeed comprised not only the strata of the lower Triassic formation (Werfener and Guttensteiner strata), but also the Lagerschiefer or slate beds, the strata of the upper Triassic formation (Wengener strata, Skonca strata), and that the slates and sandstones of the Carboniferous formation (silver slates) which occur as the roof of the ore-bearing Triassic strata, owe their abnormal position to a dislocation and overthrowal of the strata.

In the above-cited place (p. 845), it is also stated that the strike of

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\* Explanation of the geological map of the neighborhood of Idria, in Krain, by Von Mark V. Lipold. Jahrbuch der geologischen Reichsanstalt, 1874, 24 Bd. 4 Heft, S. 425, u. f.

the there described chief faulting fissure corresponds also to the like strike of the ore deposits of the Idria quicksilver mines, and that the strike of the ore deposits falls exactly in the line of the faulting fissure.

This chief dislocation fissure, which with a strike at the surface N. W. to S. E., and extending from the Kanomla valley at Raspotje, on the southern declivity of the Kobalova planina, enters the Idria ravine, and from there stretches farther to the southeast into the Idriza and Lubeuc valleys. It is found in the mine in the chief faulting cleft M (see Plate I). In the southeastern part of the mine, it is seen in the branching fissure N, parallel with M, and is just as plainly marked there as it is by the powerful breakings and fissures of the ore-bearing Wengener strata in the northwestern part of the mine. The pushing over of the silver slate upon younger ore-bearing strata is likewise clearly shown in this part of the mine. Not only the foldings of the Wengener strata, but also the boundary between the ore-bearing Triassic and the Gailthaler strata piled above them, follow exactly the strike of the dislocation fissure from N. W. to S. E.

The occurrence of ore in the northwestern part of the mine, which is disclosed by the Barbara and Theresa shafts, is quite different from that in the southwestern, in the neighborhood of the Josefi shaft. Thus while in the northwestern parts of the mine the ore occurs in connection with the upper Triassic Wengener strata, and particularly in the so-called Lager-schiefer bearing Skonca strata and the conglomerate of the latter, as also in the lower Triassic dolomitic breccia; in the first possessing the character of a bed (bedded vein), and in the latter the character of a stock-work; in the southeastern part, on the other hand, the ore occurs partly in the Werfener strata, partly in the lower Triassic Guttenstein limes and dolomites which rest immediately upon the Wengener tuffas, and chiefly in cracks which intersect the former and thus form a calcareous slaty filling with a cinnabar impregnation.

The ore here takes a decidedly vein-like structure, and the cinnabar impregnation enters the hanging as well as the foot-wall rocks of the fissures.

In this part of the mine the fissures M and N, corresponding to the chief dislocation planes, are also crossed by the ore-bearing cross-fissure O.

As above ground, so also in the mine, an ore-bearing fissure has been disclosed, parallel to the main fissure and south of it, by the "Gersdorf-Liegend-Schlag."

In the northwestern part of the mine, in which the Wengener strata (slate beds, *Lagerschiefer*,) follow the strike of the principal dislocation fissure, the foot-wall of the deposit is formed partly of Guttensteiner and partly of Werfener strata, composed of dolomite and limestone, and of sandy and chalky slate, upon which follow the tufa, marl, and hornstone slates belonging to the Werfener strata, and finally the Skonca strata, rich in ore and also bearing fossil plants.

These are abnormally overlapped by a chalk conglomerate impregnated with cinnabar, and by the dolomite breccia with Guttenstein strata, which are finally overlaid by silver slate (*Silberschiefer*).

The Wengener strata slope in the mine without reaching the surface, with a tolerably uniform N. E. dip of  $42^{\circ}$  from the level of Anthony's tunnel to the depth of 280 metres, and rise from there, forming folds in two troubles, with a S. W. pitch of  $34^{\circ}$  and  $47^{\circ}$  respectively, to a height of 80 metres, and sink thence and are again reunited in a trouble with a dip of about  $50^{\circ}$  to the N. E. (See map, Plate I.)

From these foldings originated mountain slips and dislocations which are plainly marked in the mine at the so-called "Leopoldi and Galois Wänden."

The trough originating by these foldings of the strata is completely closed to the northwest, but is open toward the southeast, where at the same time the Wengener strata, particularly the slate beds, dwindle away. The ore is contained in the form of a stockwork in the irregularly deposited lime conglomerate and dolomitic breccia in the trough and on the saddle just mentioned.

In this northwestern part of the mine the richest ores invade the Skonca strata, peculiar to the Wengener strata that is in the so-called *Lagerschiefer*.

The *Lagerschiefer*, the chief carrier of the metal in this district, is not, however, everywhere uniformly and continuously productive of ore; it is in places, even in districts, quite barren or not worth mining. In general it bears cinnabar disseminated through it; on the surfaces of

layers and fissures, on the contrary, are found fragments and nests of ore, also lentil-shaped masses of ore bedded.

The Lagerschiefer carries, almost exclusively, cinnabar; native quicksilver shows itself only in the upper portions, where the Silberschiefer rests directly on the Lagerschiefer.

The richest ore is the "steel ore," so called on account of its color, which contains up to 75% quicksilver, and occurs partly compact, partly crystalline granular. The "liver ore," dense and shining—liver colored generally—forms nests and wedges in the steel ore.

The "brick ore"—sandy, granular, bright brick-red—contains, disseminated mostly, crystalline cinnabar, and is found principally on the boundaries of rich masses, more especially where the Lagerschiefer becomes more solid and like sandstone than at the junction of the Werfener and Gailthaler slates in the dolomite breccia.

A special variety of the ore-bearing slate (Lagerschiefer) is the so-called "coral ore." Peculiar to the Skonca strata are dark, bituminous, dolomitic sandstones or slates, which bear, partly in dense masses, partly disseminated and separated, hitherto undetermined fossils, and which, on account of their similarity to corals, received this name. These coral sandstones and slates are also, now and then, ore-bearing.

The Lagerschiefer is characterized by a great content in bitumen wherever it is ore bearing; this content, concentrated in single points, forms a resinous substance, idrialite. This generally appears with the liver ores.

An usual attendant of the ore is pyrite, which, however, also occurs in the Lagerschiefer in places where there is no ore. The ore filling in the conglomerates and dolomite breccia of the northwestern region consists throughout of crystalline cinnabar, which appears partly in the conglomerate and in the cracks of the breccia, in all directions, in very delicate veins and incrustations, and partly in little nests and thicker layers. These conglomerates and breccia are particularly rich where they lie enclosed between the slate beds (Lagerschiefer), as for example in the so-called Gallois wall, or at the Silberschiefer boundary. In the latter case the conglomerate also bears native quicksilver, but at the same time the Silberschiefer also contains native quicksilver disseminated

in fine drops. Usually in this case globular segregations of crystalized pyrite are found in the Silberschiefer, which appear to have been rubbed and pressed together upon the meeting faces of the strata; these are sometimes impregnated through and through by native quicksilver.

In the southeastern portion of the mine, in the vicinity of the Josefi shaft, a folding of the strata is no longer to be seen. The strata, as a rule, rise steeply, pitch steeply, to the northeast, and are then, likewise to the northeast, abnormally overlaid or cut-off by the Gailthaler strata. The fissures M and N already mentioned, entering the mine, stretch nearly parallel with the junction of the Wengener Tufa and the Werfener strata, and the Guttensteiner strata, between h 20 and h 21 with a very steep southwestern dip. These fissures cut through not only the tufa, but also the Werfener and Guttensteiner strata.

The rich fissure O which appears in the Guttensteiner strata of this district, and crosses the stratification has a strike of from h 4 to h 16, and a flat southeast dip of  $28^{\circ}$  to  $30^{\circ}$ .

The filling of this fissure (which is often one metre thick), consists of calcareous, slaty or dolomitic masses, or breccia, which are richly impregnated with crystalline cinnabar, and often with steel and brick ore. This vein O is the richest in ore at the junction with the fissure N. From these fissures the cinnabar ore filling extends far into the hanging and foot-wall dolomite, whose fissured surfaces are for the most part impregnated with cinnabar only in thin crusts. Generally this impregnated dolomite presents cases worth mining until the impregnations in the hanging and foot-walls gradually become less and less, and at last cease entirely.

The quicksilver ore deposits at Idria carry no other metal except iron in the form of sulphide (pyrite).

Also they are remarkably poor in other minerals, and the various minerals which generally accompany mineral lodes elsewhere—for example, those of Pribram, Schemnitz, etc.—fail almost entirely. Even cinnabar, calcite, dolomite and quartz are found very rarely in perfectly formed crystals. More often they occur as intimate mixtures with each other, formed at the same time apparently.

Idrialite and anthracite are found only in compact masses. Calomel

is said to have occurred according to old accounts, but it has not been noticed recently.

Fluorspar has, however, been found very recently as a rarity in the stopes of the ascending deposits in the chief workings of N, northwest of the Gugler sink. It has a blue color, and appears as a delicate incrustation, or at most in very small crystals, together with siderite and cinnabar upon the fracture surfaces of the Lagerschiefer, and of the accompanying calcareous sandstone.

As more recent formations, are found gypsum, epsomite, and according to more recent determinations of Professor Ritter von Zepharovich\*, also Halotrichite and Melanterite.

The genesis of the quicksilver ore deposits of Idria has never been made, so far as the author is aware, the subject of a detailed discussion.

Akademie-Director, Dr. Albrecht von Groddeck, has included the ore deposits of Idria within the scope of his recent distinguished work, "*Die Lehre von der Lagerstätten der Erze*," and has drawn very instructive conclusions, not indeed upon the basis of his own studies of this ore deposit, but upon the basis of more or less general descriptions of them.

The author found, however, in the distinguished work of the Akademie-Director Dr. von Groddeck, such manifold information and stimulation that he undertakes to express and prove his own now firmly grounded views on the genesis of the Idria quicksilver deposits.

Concerning the mode of formation of the Idria cinnabar ores, whether they were formed by sublimation, by congelation from a molten stream, or by separation from solution (see Dr. v. G.'s work, p. 280), we must declare ourselves in favor of the last mode, according to which the cinnabar ores of Idria were deposited from aqueous solutions.

To this assumption we are led by the above described mode of occurrence of the Idria cinnabar ores.

The rocks in which they are often distributed as mere incrustations, show nowhere traces of very high temperature, such as sublimation, or a molten state would require. The limestone and dolomite in whose

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\* Sitzungsberichte der k. Akademie der Wissenschaften, LXXIX. Bd. März Heft, 1879.

crevices the cinnabar is deposited would have experienced a change at such a high temperature, and at least would have assumed a crystalline texture. Such a change, however, has never been noticed.

Also, the appearance of fluorspar in the crevices of the slate bed, in conjunction with cinnabar, points to the formation of the latter in the wet way. (See Dr. A. v. G., p. 322.) This manner of formation has been accepted also by Dr. v. Groddeck, who considers the Idria ore deposit to be of the Almaden type. (See pp. 105 and 302.)

That the quicksilver deposits of Almaden in Spain were formed in the wet way from cinnabar solution has been proved recently by S. B. Christy\*.

Also the descriptions which M. G. Rolland has recently given of these ore deposits in California point to their formation from a watery solution.†

There is according to this description even now in process, at Sulphur Bank, the formation of a cinnabar deposit from warm springs!! (pp. 17 and 28 of Rolland).

As to which type the Idria deposits should be referred—whether ore beds or veins—may be for the most part inferred from the above description of the occurrence of cinnabar, and has already been pointed out.

Von Groddeck classes the Idria deposits among the stratified ore deposits; among the “sedimentary deposits,” (*Ausscheidungsflötze*) which are formed at the same time as the deposit of the rock strata (pp. 303 and 306).

There is no doubt that Von Groddeck had in mind only the ore occurrence in the Upper Triassic Wengener strata; that is, in the so-called *Lagerschiefer*, in which they are indeed bedded, however, only in the manner of lens-shaped masses in accordance with the stratification of the slate.

Yet the most careful consideration and actual observation of the occurrence of the ore speak against this view. It should first of all be

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\*On the Genesis of Cinnabar Deposits. *American Journal of Science and Arts*. Vol. XVII, p. 458. 1878.

†Les gisements de Mercure de Californie, par M. G. Rolland. *Annales des Mines*. Sep. and Oct., 1878.

remembered that the ore deposit at Idria, is a pronounced dislocation fissure, which shows itself in part as a faulting fissure. This fissure formation is not confined to a single strata, for example, to the Wengener strata, but it cuts the Gailthaler strata, and all the divisions of the Upper and Lower Alpine Triassic.

So also the quicksilver ore is found in these designated formations, and is not confined to the Wengener strata (that is to say, the *Lagerschiefer*) alone. Furthermore, no one has ever found cinnabar ore occur either in the Wengener strata or the Lower Triassic group (which near Idria frequently appear above ground), outside of the extent of the dislocation fissure, so we must conclude that the ore deposits at Idria occurred after the formation of the dislocation fissure, and in consequence of it; and we designate the ore deposit as not contemporaneous with the strata in which it appears, but only as a later formation. Hence it follows that the ore occurrence in the *Lagerschiefer* is no sedimentary deposit, and it is not a true ore bed. With this view the "Permanence of Level," by which, according to Von Groddeck (p. 311), ore beds are characterized fails, for *Lagerschiefer* occurs at various points in the mine, and hardly ever bears ore in the upper parts, and in no case whatever away from the dislocation fissure.

In accordance with this mode of occurrence, we can designate the ore deposit in the *Lagerschiefer* only as a bedded vein, as the filling of ore was deposited between the Wengener strata after their complete hardening.

By the origination of this fissure, which caused not only dislocation of whole groups of beds, but also, as may be seen in the northwestern part of the mine, and especially at the beginning of the *Lagerschiefer*, foldings of the same plainly had occurred in consequence of great disturbances of the strata, as well as fissuring and crushing of the rocks, and there were formed at the same time, at the margins of the harder and more slaty rocks, peculiar friction breccia and conglomerate, and also hollow spaces.

By this kind of disturbance the slate bed (*Lagerschiefer*) was generally thrown under as a formation member with softer and more brittle rocks, as is shown in the strikes as well as the dips of the same in

the mine. The Lagerschiefer, therefore, offered the most space for the entrance of watery solutions, and this space may have been either hollow or filled with broken pieces of slate (Schiefer).

Also, it is possible that the Lagerschiefer may, by virtue of its chemical constituents and in consequence of the remains of plants which it contained, have been fitted and disposed, more than the limestone and the dolomite, for the metamorphosis and solution of its ingredients by the warm springs, in place of which the cinnabar entered.

The extent of the Idria ore deposit, which toward the surface gradually becomes less and less, and, so far as known at present, increases with the depth, shows beyond doubt that the filling mass of the Idria ore deposit in the fissure was brought up from beneath, and that the ore deposits which, as has been shown above, owe their origin to aqueous solutions, were formed by infiltration from beneath.

That these infiltrations should be richest along the bedding and slaty cleavages of the Lagerschiefer is easily explained by the before-mentioned disturbances of these strata.

Hence the nature of the ore occurrence in the Lagerschiefer justifies us in designating this ore deposit as a bedded vein (Lagergang).

The limestone and dolomite found between the Wengener and Gailthaler strata, near the folding of the mountain strata and near the overlay of the Gailthaler over the Triassic strata, have experienced every kind of mountain disturbance, shattering and fissuring, and if we may use a name introduced by Daubrée, must have experienced every kind of "Lithoklasen." As the watery solution naturally passed upward by preference between the strata of the Lagerschiefer, it also spread itself out in the bordering fissures and hollow spaces of the broken lime and dolomite, and deposited its cinnabar there. Thereby originated that wholly irregular ore deposit, which may be found well developed in the north-western part of the mine, in the breccia of the lime and dolomite between and upon the Lagerschiefer, and which the author can do nothing better than to designate by the name of a "Stockwerk."

As was above described, the ore occurs in the southeastern part of the mine (neighborhood of the Josefi shaft), in fissures or clefts. Having accepted the fact of the filling of these clefts with ore coming from

watery solution from beneath, (and there can be even less doubt of it in this part of the mine than in the northwestern part of it) the ore deposits then exhibit themselves here as pure infiltration veins.

From the foregoing presentation the remarkable fact may be seen that one and the same ore deposit occurs at Idria in three forms, all deposited at the same time and side by side, as a bedded vein, as a stock-work, and as a fissure vein.

There is yet to be discussed the question of the age of the Idria ore deposit. Dr. Von Groddeck holds that the cinnabar deposit of Idria belongs to the Triassic (p. 306).

It is quite true, as the author has shown in his "Explanations of the geological chart of the surroundings of Idria in Krain," that the ore occurrence in the Idria Quicksilver Mine is only found in the Triassic strata, which only amounts to saying that the ore products are not found in the Gailthaler strata overlying the Triassic, or in the younger mountain strata whose existence is not shown in the mine. But it has already been shown that the formation of the Idrian ore deposit was dependent on the occurrence of the great fissure in which it occurs.

As, now, this fissure certainly took place after the deposit of the Triassic strata, because the Triassic strata took part in the disturbances of which this fissure was a result, hence it follows that the ore deposits of Idria belong to a later than the Triassic period.

There are strong points for the belief that the great Idrian fault, and consequently the cinnabar deposits in it, originated in the Neogene Tertiary period. It has in particular been shown that a part of the chalky limestone occurring at Idria had taken part in the disturbances taking place with the formation of the fault, and had then sunk into the fissure after the deposit of the chalk formation; therefore, it originated in the Tertiary time.

Further, there has been found in a side ravine near Idria (Nikova ravine), outside of the dislocation fissure, south of the chief fault, an insignificantly extended trough of Eocene Tertiary strata, which at present lies a couple of hundred metres above the bottom of the Idria Basin. Deposits of Neogene Tertiary strata are not found near Idria.

We may now assume that the Idria Basin did not exist at the

Eocene period, and that it owes its origin to the great dislocation after the expiration of that period, at which time also may have been formed the diagonal fault noticed throughout the course of the Idriza river, which allowed the Eocene waters to flow off. The formation of the dislocation, and hence of the ore deposit, would then fall in the Neogene period.

Oberbergrath Stur, in the account of his travels, "Geological Relations of the Basin of Idria in Krain," (*Verhandlungen des geologischen Reichsanstalt*, 1812, No. 11, p. 235 cc.,) expresses the view that the impregnation of the Triassic strata with quicksilver ores in the Idria mine must have taken place after the deposit of the chalk limestone. He grants it appears probable that the Idrian ore deposit falls in the Diluvial period and might be contemporaneous with those ore deposits, which are found in the trachytes.

The certain determination of the manner of formation of the cinabar ore deposit is of the greatest importance to the mining at Idria, because on this foundation the further work of opening and removing the ore in depth can be more rationally conducted.

### III.

#### Mining and Ore-Dressing.

*By Adolf Planimek, Imperial Superior Mining Manager.*

##### A.—MINING.

(With a plan of the mine, Plate I.)

Near the site of the present Holy Trinity Church lies the place of beginning of the mining which was undertaken by the discoverers on the northern side of the valley slope.

But already, in the year 1500, the prospecting was carried to the southern declivity, and was reached by the still existing entrance tunnel (Antony tunnel), at the foot of the Vogelberg.

At the same time there was opened in the bottom of the valley, by the first company, a shaft which, on the 22d of June, 1508, struck a rich ore deposit. In this manner the existence of a deposit rich enough for working was established, and the foundation for deep mining was laid.

In honor of St. Achatius, whose festival comes on 22d of June, this shaft received the name of "Achazi shaft." St. Achatius was taken as the patron saint of the mine, and to the present day the 22d of June is celebrated as the Mine-patron, or Achazi Festival. The new company took the name of "Company of St. Achatius."

The Achazi shaft is placed on the chief square (formerly school square), near the house No. 82-83, and was first given up in the year 1837.

Also the "Catherine shaft," opened by the reigning prince and belonging to him, is found in the valley north of the Achazi shaft, near the house, 76-77; also the "George shaft," begun in the year 1523, east of the Achazi shaft, near Nikova brook.

By means of these shafts the mining operations were carried to the depth of the present middle level (Mittelfeld).

After the undertaking of the entire mining operations by the prince's estate, the Barbara shaft, still used at the present date, was begun, in 1596. The mining was extended already as far as the present main level (Hauptfeld).

In the year 1682 the Catherine and the George shafts were given up and closed, while the Barbara shaft, which had already reached the depth of 190 metres, served with the Achazi shaft for hoisting and ventilation.

In the year 1709 the Josefi tunnel was begun to explore the southern slope, and in the year 1736 the Magdalena tunnel was begun to explore the northern side, but neither the one nor the other met with any favorable ore output.

After the works had reached the Klementi level, the Achazi shaft was abandoned in the year 1736, and instead of it, in 1738, the sinking of a second main shaft (Theresia shaft), open at the present time, was begun and finished in 1748. At this shaft a water power with brakes was established.

The mining underwent great advances under the direction of Anton Hauptmann, 1747. Under him a new level, the Hauptmann's level, named after him, was established. Under his successor, Bergrath Anton v. Sartorri, 1754, the mine reached the present Caroli level.

In the year 1765, the St. Magdalena prospecting tunnel was opened on the western flank of the Magdalena Mountain, near the house No. 223-243, in order to see if the Lagerschiefer appearing in the Skonca open cut was ore-bearing at this depth. The very long prospecting tunnel, however, only proved the Lagerschiefer to be barren.

Another prospecting tunnel—Mary's Conception tunnel—was in the same year begun near the house No. 112-118 in Idria, at the southern foot of the Rosenberg, and was driven for some considerable distance till 1777, when it was given up, no ore having been discovered.

The great quicksilver production in the years 1786 to 1802 gave rise to the opening of new shafts.

In the year 1786 the Josefi shaft was begun, and in 1792 the Francisci shaft. In order to bring water power to the latter, in the year 1792, the Ignazi tunnel was driven from the water ditches supplying the works through the Antony ridge on the southern flank, and through it the water was brought from the works to the Francisci shaft.

In the year 1810 the mining was extended to the Barbara level.

In the year 1819 the prospecting drift at the level of the Mittelfeld to the south of the Josefi shaft was begun, which was called the "Crown Prince Ferdinand Prospecting Drift," in remembrance of the presence of the Crown Prince at Idria that year.

For the same purpose, that is the prospecting of the ground in the southeastern part of the mine, the Ferdinand shaft was opened in the year 1836. This shaft reached, in 1853, the depth of 100.5 metres. At a depth of 99 metres a cross-cut opening was made to join the Crown Prince Prospecting Drift.

In the year 1842, the Francisci shaft was brought to the depth of 276.9 metres, and at 269 metres below the mouth of this shaft, the deepest level, the Francisci level was begun.

In the month of February, 1840, the Mayer sink was begun, and finished in 1876, at the Francisci level. Also in the year 1863, a further deepening of the Josefi shaft, from the Barbara level, was begun, and since April, 1874, continued by machine boring, until, in 1876, it reached the level of the Francisci horizon, at a total depth of 286.1 metres.

In order to increase the water power, the Floriani water tunnel from the Idriza river below the metallurgical establishment, was begun in 1846, and in 1854 connected with the Francisci shaft.

In 1847 a new shaft, the Dreikönig shaft was begun to serve as a chief hoisting shaft. The shaft was sunk to a depth of 15 metres, and then connected by a bore hole, 76 metres deep, with the Floriani level. As, however, the bore hole opened up considerable quantities of water, a further sinking of the shaft from the surface was abandoned, and the shaft was filled up. Instead the Dreikönig was sunk as a blind shaft from Mittelfeld (level, horizon) to Carolifeld, and in 1878 its further sinking to the Franciscifeld was undertaken.

The quicksilver mines of Idria consist of 22 single claims, with a superficial area of 45 hectares, 11 ares and 70 square metres, and possesses the exclusive right of prospecting in the entire district of the former dominion of Idria.

The mining map (Plate I) shows the present condition of the mine.

This very extensive mining district is worked by 6 shafts and 2 tunnels.

The relative distances and positions of each with reference to the Josefi shaft, taken as a central point, as also the height above the sea level of the tunnel mouths, and the crowns of the shafts, as well as the absolute depths of the shafts, are given by the following table :

Name of the Surface Opening.	Measured from Center of Josefi Shaft.				Height of Crown of Shaft or Tunnel Mouth above Level of Adri- atic Sea.	Absolute Depth of Shaft.
	Direction.			Dis- tance.		
	h.	o°	o'	Metres.	Metres.	Metres.
1. Josefi Shaft.....	..	..	..	.....	356.4	286.7
2. Petri-Licht Shaft.....	16	7	24	532.6	374.9	228.1
3. Barbara Shaft.....	16	8	..	623.2	342.0	229.5
4. Theresa Shaft.....	19	6	30	660.7	344.6	231.4
5. Francisci Shaft.....	21	6	36	712.9	344.3	276.9
6. Ferdinand Shaft.....	8	7	18	665.5	342.3	100.5
7. Antony Tunnel.....	15	10	30	733.6	337.4	.....
8. Floriani Water Tunnel.....	23	3	36	1356.5	327.1	.....

The quicksilver ore deposit is at present opened on 12 horizons or levels, with drifts along the strike for a distance of 1500 metres, and by means of crosscuts for a width of 570 metres.

These main horizons or levels, which bear the local name of "Felder," are, on the one hand, directly connected with one or more of the main shafts, and on the other, partly by means of 27 inclined sinks, here called "Rollen," and partly by means of 30 vertical sinks of different depths.

The following table contains the names of the different levels, together with their height above the sea level, the height between each

successive pair of levels, their depths below the bench mark on the crown of the Josefi shaft, and the length of each level along the strike:

No.	Name of the Level.	Height above Sea Level.	Distance between Successive Levels.	Depth below Bench Mark on Crown of Josefi Shaft.	Length of Drifts.
		Metres.			
1	Achazifeld .....	296.4	60.0	60.0	1,084
2	Florianfeld .....	263.8	32.6	92.6	1,482
3	Mittelfeld .....	238.5	25.3	117.9	3,575
4	Hauptfeld .....	216.0	22.5	140.4	1,547
5	Grossherzogfeld .....	205.5	10.5	150.9	2,887
6	Wasserfeld .....	183.5	22.0	172.9	3,476
7	Clementifeld .....	171.2	12.3	185.2	1,192
8	Hauptmannsfeld .....	161.2	10.0	195.2	3,518
9	Carolifeld .....	147.0	14.2	209.4	1,300
11	Bararafeld .....	129.4	17.6	227.0	1,902
12	Josefifeld .....	104.8	24.6	251.6	590
13	Franciscifeld .....	73.7	31.1	282.7	310

Sum of differences of levels, 282.7 metres.

Average differences between levels, 21.8.

Sum of lengths of drifts, 22,863 metres.

Average length of drifts, 1,758 metres per level.

The just stated length of the drifts of 22,863 metres, with the addition of 1,471 metres in the Antony tunnel and the Josefi tunnel, and of the 2,264 metres in the Floriani tunnel for water, a total length of 26,598 metres, of which 16,503 is along the strike of the deposit, and 10,095 metres consists of cross-cuts. The drifts along the strike are in the northwest district, partly along the main strike of the descending bed vein, at the contact of the Skoncaschiefer (Lagerschiefer) with the Wengener tufa, partly along the main strike of the two rising branches of the bedded vein along the contact of the Skoncaschiefer, with the Gailthalerschiefer, or the Guttensteiner limes. In the south-east district, on the other hand, they follow the strike of the fissures, M, N, O, and O', or the contact of the Guttenstein strata with the Werfener strata, or the Wengener tufa.

From these main levels along the strike, the deposit is cut by north

cross-cuts upon the different levels until the Gailthaler schists are reached. The south cross-cuts pass through, one after another, the Wengener and Werfener strata. Only two cross-cuts, one the Gerstorf, south cross-cut of 339 metres, and the other, the Stadlersink south cross-cut of 308 metres, cut the here normally stratified Gailthaler strata.

As has already been stated in the geological part, the ore occurrence in the Wengener strata of the upper Triassic formation, in the northwest district, assumes the character of a bedded vein, and the ore occurrence in the Guttenstein lime and dolomite of the lower Triassic in this district takes the character of a large stockwork, in consequence of the many foldings and fractures of the strata. This stockwork is bounded on the north by the overlaying Gailthaler schists, and on the south by the Werfener schists and limes.

The extent of this district, which will pay for mining, is along a vertical depth of 282 metres, along the strike 430 metres, and with a varying thickness of 10 to 70 metres.

In the southeast district, where the rich ore occurs in the fissures M, N, O, and O', and along the contact of the Guttensteiner limes, with the Werfener and Wengener strata, the ore deposit follows the strike, and is bounded by the surfaces of the fissure, or of the contact walls, and has more extent in length and depth than in thickness. These ore fillings of the fissures and the contact surfaces, were prospected and opened from the Wasserfeld to the Josepfeld under the former Mining Directory, only recently, by Imperial Bergrath, Peter Gröbler. In the most recent times they were opened from the Josepfeld to the Franciscifeld, and form at present the purpose of the most active prospecting and development.

Also the testing of richness of the bed-like vein and stockwork deposits of the northwest districts, in further depth, is now being undertaken by the working of the Stadlersink drift in the hanging wall, as well as by the rapid sinking of the Dreikönig shaft below the level of the Barbarafeld by the use of compressed air for pumping and hoisting.

The method of working here in use by means of which the described ore body has been laid open to the extent of 14,000 square

metres is floor working with stowing, which is carried out in such a manner that the east and west lying main levels, which are on an average of 21.8 metres apart, are cross-cut north and south as far as paying ore is found, and then these are joined by drifts, running parallel to the main levels. The mass to be mined is now cut into rectangular blocks of different sizes by means of drivages, two metres wide by two metres high, which run from the cross-cuts to the middle, beginning at the extreme north and south limits, avoiding at the same time the entire removal of the barren part of the deposit near the main levels. The roof so laid open, is supported by timbers about one metre apart, and made safe by regularly added waste material or stowing.

After the complete removal of this layer or course, the stoping of the next two metre high course, or floor above, is undertaken partly directly from the main sinks, partly from the numerous upraises to the next higher floors, and is carried out upon the stowing in exactly the same manner as in the floor below, and so the higher floors are opened, and filled up in the same order as if worked by overhand stoping.

The yearly amount of excavation, according to the returns of the last four years, amounts to 13,600 cubic metres of solid material, which, with a stoping breast two metres high, corresponds to a working area of 6,800 square metres.

The cost of excavation amounts to 3 florins, 35 kreutzers, Austrian value per cubic metre, inclusive of materials; the net cost after deducting 41 kreutzers for materials amounts to 2 florins, 94 kreutzers per cubic metre.

The output from a produce of 13,600 cubic metres of solid material was on an average 326,000 metrical centners [ore], with a metallic content of 4,272.60 metrical centners of quicksilver, or a metallic content of 31.41 kilogrammes of quicksilver per cubic metre of solid material, or a content of 1.31 kilogrammes of quicksilver per met. cent. of product.

The appended table gives a survey of the extent of the working area at present opened on the different levels, their height, the consequent amount of material worth working originally present, the amount already mined, and the cubic content which is still at hand (in sight).

No. of Level.	Name of Level.	Average	Relative	Ore Mass.		
		Working	Height	Originally Present.	Already Mined.	Still Remaining.
		Area.	Stopes.			
		Sq. Metres.	Metres.	Cubic Metres.		
1	Achazifeld . . . . .	1,073	60.0	64,380	12,880	51,500
2	Florianfeld . . . . .	1,976	32.6	64,420	5,330	59,090
3	Mittelfeld . . . . .	2,970	25.3	75,140	26,040	49,100
4	Hauptfeld . . . . .	9,208	22.5	207,190	41,320	165,870
5	Grossherzogfeld . . . . .	12,779	16.5	210,750	105,120	95,630
6	Wasserfeld . . . . .	14,224	16.0	227,580	86,750	140,830
7	Clementifeld . . . . .	11,128	12.3	136,870	61,870	75,000
8	Hauptmannsfeld . . . . .	9,141	32.3	174,940	44,010	130,930
9	Carolifeld . . . . .	3,030	14.2	43,030	.....	43,030
10	Barbarafeld . . . . .	4,189	49.4	101,360	7,040	94,320
11	Josefifeld . . . . .	1,022	24.6	25,140	2,790	22,350
12	Franciscifeld . . . . .	1,022	31.1	31,780	.....	31,780
	Sum . . . . .	47,845	282.7	1,352,580	393,150	959,430

The still remaining ore mass of 959,430 cubic metres would, at the rate of 13,600 cubic metres, last for 70½ years.

The metallic content of this ore mass of 959,430 cubic metres, reckoned at the rate of 0.314162 metrical centners of quicksilver per cubic metre of solid material, would contain 301,420 metrical centners of quicksilver, which metallic content, at the rate of the average price for the last hundred years, of 300 florins, Austrian value, per metric centner would possess a value of 90,426,000 florins.

The filling of the worked-out portions is accomplished by using the material from the drifts and prospect tunnels, as also the material broken out in widening out work by the mason and the timberman, as also the barren rock separated from ore in the mine or in the sorting-house. The rock required, beyond what can be furnished in this manner, is taken from open cuts on the surface.

The stowing, which must be done with the greatest care, is done by contract, by a particular set of workmen, who have also to transport the barren material. One cubic metre of the filling costs on the average 70 kreutzers, and hence the filling of a running metre of the stopping drifts costs 2 fl. 80 kr.

The material broken in the stopes is there separated by the stopers into ore, ore to be spalled, and barren rock; the ore and the ore to be picked are wheeled in Hungarian cars (Hunde) to the ore shoots communicating with the main drifts and dumped into these. The barren stuff is, on the contrary, put aside for the stowing. The transportation of the ore and spalling material from the shoots to the hoisting shaft is undertaken by carmen, along iron tracks, in cars which hold about five metric centners, to the shaft stations; from these it is loaded by the station-men into the cages (Förderschale), by means of which it is hoisted to the surface.

The transportation expenses vary between 4.5 and 7 kreutzers per car, according to the length of the drifts and the depth of the shafts.

Until the most recent times the shafts were worked by means of buckets (Tonnen). The cage hoisting required the previous widening of the generally narrow and old-fashioned shafts, which not only consumed much time, but considerable money, as it was necessary to undertake an entirely new timbering of the shafts, which were already timbered solid in most cases. So the work was begun in May, 1870, and the arrangements for cage hoisting were finished and they were put in operation as follows: the vertical Josefi shaft in December, 1872; the vertical Theresia shaft in December, 1873; in the Barbara shaft, inclined at 80° in August, 1878.

The timbering of the shafts, on account of the commonly broken character of the ground, (Gailthaler and Werfener schists and Guttenstein limes and breccias) is mostly solid oak or fir; only the Josefi shaft, from the Mittelfeld to Franciscifeld, at a depth of 154.4 metres, is timbered by open sets with lagging.

The timbering of the sinks or winzes, where timbering is used at all, is by either close sets or open sets, according to the nature of the ground.

The main drifts in the less heavy ground are timbered with sets mostly 1 metre apart, with partial backing of fir or elm.

Drifts, Rollen (inclines) and sinks, which run through very heavy ground and serve for transportation, are lined with masonry.

The masonry linings were first introduced in 1752, in the Anthony

tunnel, and since then have been largely in use. For the winzes a circular section has been chosen. They have an interior diameter of 1.6 metres. The lining of the drifts and inclines (Rollen) is elliptical, in section, the major axis being 2.2 metres, and the minor 1.6 metres; also, the stations are mostly lined with mason-work.

One of the most difficult pieces of underground masonry-work was begun in May, 1877, and finished at the close of the year 1879. It was a chamber 18 metres below grass, next to the Theresia shaft, for the reception of the water-pressure engine, and has an inside height of 7.4 metres, a width of 6 metres, and a length of 23 metres.

The ventilation of the mine is a natural one. The Josefi, Theresia, and the Franz shafts, serve as down-cast shafts, and the Barbara shaft and the masonry-lined Petrilicht shaft as up-casts. The mine is in all parts well ventilated.

The cost of mining, according to the results of the last year, amounts to 63.4 kreutzers per metric centner of produce.

The mining gives employment, inclusive of those engaged in picking ore, to 460 men permanently, and 200 men at times besides, making in all 660 men.

The present surveying staff has at its command a large number of mining and geognostical maps, as well as plans of the underground workings, some of which reach back into the year 1734.

The last complete survey of the whole mining district, for which the Saxon instrument (Schienzeug) was exclusively used, began in 1824; the additions of various degrees of accuracy reach from this time to the present. In this manner not only has the original map lost much of its accuracy, but there appear in the copies of the workings and their subsequent copyings for their multiplication, very considerable errors, so that there was a great need of an entirely new undertaking of the survey of the whole complex mining works.

This new survey was begun in the summer of 1878, upon the basis of a former surface triangulation controlled by two base lines, by which the crowns of all the shafts and mouths of all the tunnels were included in the net, and after connecting the most important surface points with

fixed points under ground, the measurement of the different levels and the mapping of the new work is in most active operation.

There are used for this purpose, in the drifts with iron tracks, a 14-centimeter repetition theodolite of Junge's construction, and a small magnet theodolite of Breithaupt's; in drifts free of iron, Plaminek's hanging compass.

The general maps are on a scale of 1:1000, the levels and those of the workings on a scale of 1:500. Each leaf or folio has a length of 80 centimeters and a breadth of 60 centimeters.

## B.—ORE DRESSING.

Originally the ore dressing consisted in a sorting of the ore according to the content and size, by hand picking and screens, and finally by washing in troughs.

In 1696 the first stamp battery was built, and since then all the produce has been stamped.

In 1736 an improvement in stamping, washing and elutriating took place, and the still existing stamping and separating house was erected.

The product coming from the mine was separated into Grubenerzgefälle, Grubenscheidgefälle, and Waschgänge, from the first and last of which ore was won by hand picking.

The ore to be washed (Washgange) was treated on screens with water (Reibgitter), and then concentrated either by being picked over, if coarse, or by being sifted if fine, or by being washed on inclined hearths, if very fine (Liegendherden). The material separated out for stamping, together with the poorer residues from sifting, were taken to the battery, and were crushed wet in a five-stamp battery, and the pulp partly sorted by troughs concentrated to "slick" partly on inclined hearths (Liegendherd), and partly on percussion tables.

In 1842 the washing and wet crushing, and the wet concentration generally, were put aside, and instead the dry concentration only introduced, after it had been established that considerable losses of quicksilver took place in the wet dressing, and when also they had begun to treat poorer ores.

The order of dry preparation of the mine product is now as follows: The broken ore is, as has been stated in the part on mining, separated in the mine into ore, ore to be picked and waste, so that only the two former are removed to the surface. At the shafts themselves are placed grizzlies, with a width between the bars of 100 millimetres, upon which the ore, and the ore to be picked are dumped, to separate the smalls in each case from the coarser materials.

The coarse "ore" is always, and the ore to be picked, in part, broken by the Blake's stonebreaker.

Beneath the mouth of the breaker are placed sheet-iron sieves, with meshes of 20 millimetres and 10 m. m. respectively. The sieve residues from the 20 m. m. sieve are separated on a revolving table into rich ores, poor ores, and coarse ores (Stufen).

The sieve residues from the 10 m. m. sieve go to the coarse rolls; that which falls through the sieve to the fine rolls, from which the material passes through a 5 m. m. sieve, of which that which passes furnishes sifted ore ready for metallurgical treatment.

The rich and poor ores above 20 m. m. are stamped dry in a battery. The smalls from the 100 m. m. grizzly are thrown upon a sieve with 50 m. m. wide meshes, and the sieve residues go to the rock breaker.

That which passes through the sieve goes to a drum sieve provided with three sieves with meshes of 20 m. m., 10 m. m., and 5 m. m. The residues from the 20 m. m. sieve are conducted to a band-sorting table (Bandklaubtisch), on which the rich and poor ores, the stufen and waste rock, are separated. The ores are taken to the dry-stamp battery, the stufen to the metallurgical works, and the waste goes back to the mine for the stowing.

The residues from the 10 m. m. sieve go to the coarse rolls; that from the 5 m. m. sieve to the fine rolls, and that which passes through the sieve goes as sifted ore to the works.

The dry battery consists of five sets of five stamps each, and treats the rich and poor ores of 20 to 50 m. m. diameter, which are stamped separately. The product of the battery goes to a 5 m. m. drum sieve, and that which passes through furnishes the stamped rich and poor ores; the sieve residues go back to the battery.

Of the coarse ore to be picked, only a small part is treated by the rock breaker, which is used with widened jaws, and the 10 m. m. sieve is removed. The residues from the 20 m. m. sieve go to the rotating picking table, at which, chiefly, stufen worth treating and some ore are produced, and the barren waste removed.

That which passes the sieve goes to the works as fine-sized ore (Griese), worth treating.

The coarse ore to be picked, which varies from 20 m. to 50 m. m., is separated into ore and waste, after having been through the battery.

The ores are taken to the dry-crushing battery.

The smalls from the ore to be picked are dumped into the upper story of the sorting house upon inclined, fixed sieves with 30 m. m. meshes. The sieve residues give Stufen, and that which passes gives medium-sized ore (Griese), both worth treatment.

Important improvements in the mode of working are on the point of being made; thus the chamber for storing coarse and medium ore, as well as the railway track, will be brought to the 3.7 m. higher level of the gutter, in order to give more dumping room.

Instead of the fixed grizzly of 100 m. m. mesh width for coarse, and the 30 m. m. mesh, with one for the coarse and medium ores, there will be erected four self-acting Neuerburger's screens, with 90 m. m. and 30 m. m. width between the bars, and the coarse ore (Stufen), formerly no further treated, will, before deposition in the Stufen chambers, be subjected to a sorting on four sorting tables (Bandklaubtischen).

Instead of the dry crushing battery, which is capable of little work, a set of coarse and fine rollers will be used.

The following table contains the average yearly production of the ore-dressing works, together with the percentage content and the total content in quicksilver, according to the results of the last four years:

	Dry Weight	Quicksilver Content.	Quicksilver Content.	
	Metric Centners.	Per Cent.	Metric Centners.	Kilo-grammes.
Ores.....	21,000	9.28	1949	..
Stufen.....	112,000	0.51	566	40
Griese.....	193,000	0.91	1757	20
Sum.....	326,000	1.31	4272	60

The average number of men employed in preparation of ore is 13 permanently, 60 at intervals; total, 73. The cost of dry concentration amounts to 36 kreutzers per metrical centner of concentrations.

## IV.

### Reduction and Vermilion Works.

*By Heinrich Langer, Imperial Manager of Works.*

#### A.—QUICKSILVER REDUCTION.

With respect to the original method of winning quicksilver it may be stated that it consisted in a simple washing of the silberschiefer impregnated with quicksilver, upon sieves. This method was still retained when they came to take out cinnabar, as the ore obtained by washing was subjected to a simple roasting in heaps. The ores were piled in alternate layers with wood, in heaps similar to charcoal heaps, covered with turf and set on fire. After extinguishing and cooling, the quicksilver was obtained partly free and partly by washing the roasted mass. These manipulations were mostly undertaken in peculiar fire-places in the nearest ditches, and there thus arose many of the now peculiar names of places—"Brandgraben," etc.

In the third decade of the sixteenth century the method "*per descensum*," described by George Agricola, was introduced. By this method the ore, in earthen vessels placed one over the other in pairs, was heated by an open fire, first freely and then covered, and there exists yet a permit from the reigning prince for the erection of a quicksilver-roasting and cinnabar-smelting works on the Lend, dating back to November 5th, 1537.

In 1580 the first manager of the united works, Franz Khisel, introduced a new method of reduction (roasting), by which an addition of burned lime was made to the ores.

In 1641 the manager, Bartholomaeus Pacher, introduced vessels of cast-iron, which in 1665, as Valvasor in his Chronicle communicates, had a retort form.

In 1668 Servati built 14 new retort furnaces, each with 50 retorts, which is also confirmed by Brown in Valvasor's Chronicle.

In 1696 manager Johann Friedrich Stampfer v. Walchenberg used conical-shaped wrought-iron retorts, and in 1715 he also erected ten new furnaces with closed fires, in the manner usual in the Rheinpfalz.

The expensive labor at these furnaces, as also their small output, gave rise to the introduction in 1750, under Bergrath Anton Hauptmann, by Bergverwalter Poll, of the Bustamente or Spanish Aludel furnace, which was largely improved upon in 1770, by roasting master Ignaz v. Passetzky, who introduced clay gutters provided with covers, instead of Aludels, and enlarged and increased the number of vapor chambers.

The large contract to furnish quicksilver concluded with Spain towards the end of the preceding century required a more rapid production than was possible in the Aludel furnaces, and for this reason there were built in 1787, by Governmental Consul Josef v. Leithner, seven vertical flame furnaces (Leithner furnaces), with masonry condensation chambers (vapor chambers), which in 1792 were changed and united to form double furnaces.

The trouble of making the slick into bricks induced experiments towards working the same by building hearths in the Leithner furnace, which in 1808 led to the introduction, by Oberhüttenverwalter Leopold v. Passetzky, of earthen roasting dishes.

In 1825 followed again a rebuilding of the vertical flame furnaces, so that out of these a double furnace (Franz), and a quadruple furnace (Leopoldi furnace), were constructed. These two furnaces remained in operation until 1859 and 1870 respectively. In the latter year the operations were completely abandoned on the left bank of the Idriza.

The difficulty of treating the great amount of Griese in the vertical furnaces; the relatively great expense of this intermittent treatment, as also the efforts for better condensation, gave, in 1842, Bergrath Alberti occasion to introduce through the then manager of the works, Martin Glowacky, the continuously working reverberatory furnaces (Alberti furnaces) with inclined iron condensation tubes, cooled by water. Of this furnace system five double furnaces still remain in operation.

In the same connection, on the recommendation of Hähner, the Saxon Consul General at Livorno, there was built in 1849, a continuous working shaft furnace (similar in principle to the Swedish iron roasting furnaces), with charcoal as fuel, and provided with masonry condensation chambers with tops of iron plates cooled with water, which, however, on account of unfavorable results, had to be abandoned, after several campaigns, in a few years. In the same year was tried a horizontal furnace with desk firing, and a second with a hearth of iron heated from beneath, and with condensation tubes lying in water.

In the years 1868 and 1869 were built four shaft furnaces, according to the pattern of those in use at Vallalta in Venetia. These furnaces, like the reverberatory furnaces, were provided with inclined condensation tubes, a part of which were of wood, and with small masonry condensation chambers. Two of these remained in operation until the year 1878, while the others were already, in 1871, broken down. In 1869 there was erected for the experimental treatment of rich ores a tube furnace, according to the plans of Imperial Ministerial Counselor P. Ritter v. Rittinger.

After the trial at a previous period of one of the muffle furnaces based upon Ure's principle, for the burning of soot (Stupp), it was resolved in 1869 to introduce the muffle furnace method for (Stupp) soot and rich ores. With this idea there were built first, three, and in 1871, six muffle furnaces, which had iron tubes standing in water for the purposes of condensation. Likewise in the years 1872 and 1875, muffle furnaces after Bergrath Paterna's system were built, and roasting experiments were conducted with ores with a weak current of air.

The already well-known fact of the penetration of the furnace walls and condensation chambers by metallic quicksilver and its combinations, freshly confirmed by the pulling down of the old furnaces, gave rise to the introduction of iron shells with a light lining of masonry, as also of light wood and masonry constructions for condensation chambers, together with tubes cooled by means of water.

In this manner several were built by Bergrath A. Exeli, who conducted the works from 1869 to 1876, and in 1871 built the first iron-clad reverberatory furnace, with exterior bent-iron condensation pipes

of small diameter and leg-formed arrangement, and with condensation chambers of stucco (stuccatur); also, the first iron-clad shaft furnace, with flame firing and the same condensers as in the reverberatory furnaces; also, in 1876, two other shaft furnaces of the same construction, with standing condensation tubes of stone-ware of larger diameter, cooled by water.

Since the year 1871 all distillation and furnace gases, with the exception of the furnace products from the heating of the muffles, are conducted through a subterranean flue, built in this year, to the central chimney, 158 m. above the level of the works, and in 1873, in order to more perfectly condense the quicksilver vapor, four more large condensation chambers were built between the canal system and the central chimney, behind which a special fireplace is arranged, in order to regulate the draft.

The experience gained by the attempt to make soot bricks (Stupp Ziegeln), by mechanical means for the muffle furnace operations, led Bergrath A. Exeli to set up the two first experimental soot presses, which proved so good, that in 1873 the three presses now in use were erected and set in operation, by which the former costly and unhealthy dressing of the soot by hand was entirely replaced.

In the year 1873, also, were built two Alberti furnaces, with gas producers and arrangements for heating the hearth, but the gas firing has been changed for an ordinary grate firing.

In 1875 the iron-clad reverberatory was changed into one in which the ore is handled continuously (Fortschaufelungsofen), the condensation apparatus remaining the same.

These newly arranged furnaces, together with the old Alberti furnaces, (the latter with the changes yet to be mentioned), are still in actual use.

A very considerable increase of the capacity of the works was reached by the erection of a new shaft furnace construction, according to the plans of the Imperial Hüttenverwalter J. H. Lange (1878-79).

This shaft furnace construction consists of four furnaces united within one iron jacket, and has the capacity of roasting daily 750 metric centners of Stufen. For condensation are used iron tubes standing in

water, and masonry chambers covered by iron plates, cooled by water. These are made tight, with advantage, by means of asphalt.

The former project of altering the old Alberti furnances into Fort-schaufelungsöfen was given up because these changes would have been for a long time prejudicial to the capacity of the works which was no longer sufficient. On the contrary the "Board of Works Inspectors" was, in 1877, opportunely urged by the Imperial Ministerial Commissary, now Imperial Oberbergrath E. Jarolimek, to erect a new reverberatory plant, which was also approved by the Imperial Agricultural Ministry. This new plant, whose buildings are now half finished, is intended for twenty furnaces. There are at present four of these on the plan of Imp. Bergrath J. Cermak, who undertook the management of the works at the close of 1876, which are on the point of being undertaken. They are constructed as continuous furnaces (Fortschaufelungsöfen) two have plain grate fire-places, and two are provided with step grates and have double tube condensers, similar to those of the shaft furnaces.

The testing of these will decide upon whether or not they shall be retained as the system for roasting Gries and fine ores. On account of the great importance of automatic and continuous acting furnaces for Idria, preliminary experiments were made already in 1877 upon the use of this principle for quicksilver metallurgy, in a simple, and, therefore, practical modification of the method in use in diverse metallurgical processes. And by such a furnace system in combination with the changes in roasting planned at the same time by the present manager, for combined heating of the hearth and the use of hot air, the attempted further cheapening of the working of Gries and the diminishing of the soot may be reached.

As useful improvements in recent times may be added: the introduction of a premium dependent on the charging and yield or output for the reverberatory and shaft furnace workmen; the change of construction of the Alberti furnaces so that the flame comes directly into the working hearth; and the introduction of brown coal firing on the large scale, so that not only is there a better use of this fuel for the quicksilver roasting, but also the long desired wish of the forester for the sparing of the forests and their better utilization by allowing

them to produce larger and more valuable timber is borne in mind and accomplished as far as possible. This saving of expense in fuel was especially important for the relatively dearer muffle furnace operations and for the others also of decided influence.

In the year 1880 there was also put in operation successfully the filter chamber, according to the ideas of Imp. Assayer E. Teuber and Imp. Bergrath A. Exeli, through which the escaping vapors of all the furnaces have to pass.

In the assaying of the ores, the old method of quicksilver assaying in cast-iron retorts with clay condensers, and the use of lime, was in vogue until 1873. Since this time all assays were conducted by means of Eschka's gold cover method. Recently Assayer E. Teuber introduced the well-known method of reducing the stuff to be assayed by means of the reduction cone, which is all the more necessary since the order of the Imp. Agricultural Ministry now requires that five per cent. of the highly variable product of the mine should be taken for assay for which purpose a particular testing house was built. The taking of samples on the larger scale by means of the cone is likewise introduced.

If the account of the metallurgical operations sketched in the foregoing is considered, a steady development may be noticed, which includes not only the scale, but the manner of working, and appears directly related to the progressive development of the mine.

While in the period of the open heap roasting and the distillation "*per descensum*," as well as the retort furnaces, only rich ores could be treated, which at the mine had to be metamorphosed at great expense and with considerable losses from the raw ore into slick and lump ore (Kernerzen); and also the Spanish furnaces, as also in part, the Leithner furnaces, treated rich ores only. The attempts at the present time are to work the poor ores which occur in large quantities without a concentration of its ore content, by which means the intention of the mine to render valuable the poor ores also will be accomplished.

The present metallurgical works of Idria for the purpose of working the ores from the mine lie, within the city for the most part on the

right bank of the Idriza, whose water serves as a source of power, and consists of the following objects:

(a) One ore magazine which contains twenty-one chambers with a capacity of 750,000 metric centners of ore produce, and is connected with the sorting house by means of a horse road.

(b) One sample house (Proben haus); for preparing the samples, containing one of La Motte's mortar mills and one of Sachsenberger's Ball Mills for grinding Griese, Stufen, and residue assays, driven by a twelve horse-power movable motor.

(c) One assay office with balance rooms, laboratory and crushing room for assays and chemical investigations, and also a weighing place for the bridge scale used for weighing the ore brought in by the ore road.

(d) The old roasting building which contains:

Ten Alberti reverberatory furnaces of older construction with inclined iron condensation tubes.

Two Alberti furnaces of newer construction, with hearth heating and iron leg condensation tubes.

One iron-clad continuous furnace (Fortschaufelungsofen), with hearth heating and iron leg condensation tubes.

Here is also placed the apparatus for the manufacture of vermilion in the dry way.

(e) A shaft furnace plant, consisting of:

Four iron-clad shaft furnaces of newer construction, with tubes standing in water, with chambers covered with iron and cooled by water.

One iron-clad shaft furnace of the older construction, with iron leg tubes of cast-iron.

Two iron-clad shaft furnaces of older construction with standing condensation tubes of larger diameter, part of iron, part of stone-ware.

(f) A muffle furnace plant, with six muffle furnaces, each with two muffles, with standing condensation tubes of small diameter, made of cast-iron and placed in water boxes.

In the muffle furnace building are found besides these, a store room and packing room for quicksilver; and further, three Schupfen, with drying rack for ore brick preparation.

(g) The Soot Press room with:

One packing room with four reservoirs for quicksilver.

Three soot presses and one soot chamber.

(h) One Turbine (Fourneyron), of eighteen horse-power for driving the

(i) Centrifugal pump for lifting the condensation water.

(k) One circular saw driven by one four horse-power water wheel.

(l) One condensation chamber system of four chambers, which is on the one side connected with the whole furnace system, on the other with the central chimney 158 metres above the floor of the works, by means of underground flues.

(m) One bath house with tub, douche, and steam baths.

(n) One manager's building.

(o) One Patera's muffle furnace—experimental furnace.

(p) One six horse-power water column hoist for lifting the residues of the reverberatory furnaces from the waste pits to the floor of the works.

(q) One suction and pressure pump for lifting the condensation water.

(r) One old bath house, with two large basins and one small one.

On the point of being built are:

(s) The new reverberatory furnace works for twenty five ore (Gries) furnaces, of which half the building, of a front length of sixty-eight metres and the condensation chambers for four furnaces are completed; the four furnaces themselves, together with their condensation tubes, are on the point of being built.

(t) The above ground main vapor canal for the conduction of the fumes from the furnaces of the new plant to the main condensation chambers; this serves at the same time as the enclosing wall for a part of the works.

On the left bank of the Idriza are the Pottery works still in operation, with two baking furnaces and the other arrangements for manufacturing the clay-ware and vessels in use in the works.

In the last three years the following amounts of ore were worked in the mine:

1877.	333,114	metrical centner	Average	Content...	<sup>Hg.</sup> 1.371 %
1878.	330,042	"	"	"	... 1.360
1879.	406,266	"	"	"	... 1.076
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Total,	1,178,422	"	"	"	... 1.10% Hg.

The ore furnished the works is separated into three groups, according to the content and size of fragments, as follows:

(1.) *Stufen*, such coarse stuff, or such ore to be roasted, which will not pass a sieve of twenty m. mesh width, and whose content varies from 0.20 to 0.80 per cent. Hg.

The average content of the *Stufen* in the last three years was:

1877.....	0.56% Hg.
1878.....	0.53 "
1879.....	0.42 "

Its composition was, according to the analysis made of the average of the whole yield for 1878, by Assayer E. Teuber, at the laboratory here, as follows:

Mercuric sulphide, HgS.....	0.62 %
Mercurous chloride, Hg <sub>2</sub> Cl <sub>2</sub> .....	trace
Basic mercuric sulphate, 3 HgO, SO <sub>3</sub> .....	0.
Ferrous carbonate, Fe CO <sub>3</sub> .....	0.76
Calcic carbonate, Ca CO <sub>3</sub> .....	35.75
Calcic sulphate, Ca SO <sub>4</sub> .....	0.53
Magnesian carbonate, Mg CO <sub>3</sub> .....	27.17
Magnesian sulphate, Mg SO <sub>4</sub> .....	0.21
Double iron sulphide, Fe S <sub>2</sub> .....	4.24
Alumina, Al <sub>2</sub> O <sub>3</sub> .....	1.64
Phosphoric anhydride, P <sub>2</sub> O <sub>5</sub> .....	0.
Aluminic silicate, Al <sub>2</sub> O <sub>3</sub> (SiO <sub>2</sub> ) <sub>3</sub> .....	16.48
Ferric silicate, Fe <sub>2</sub> O <sub>3</sub> (SiO <sub>2</sub> ) <sub>3</sub> .....	0.
Silica, SiO <sub>2</sub> .....	11.52
Bitumen, water and loss.....	1.08

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100.00 %

(2.) *Griese* or smalls, all stuff smaller than the Stufen, and of a content of about 1 per cent. Hg. The content of the same during three years was, viz:

1877.....	0.94 % Hg.
1878.....	1.02 " "
1879.....	0.79 " "

The composition of this was, from the analysis of Assayer E. Teuber, for the average of the yield for 1878, viz:

Mercuric sulphide, $\text{HgS}$ .....	1.25 %
Mercurous chloride, $\text{Hg}_2\text{Cl}_2$ .....	trace
Basic mercuric sulphate, 3 $\text{HgO}$ , $\text{SO}_3$ .....	0.
Ferrous carbonate, $\text{Fe CO}_3$ .....	3.17
Calcic carbonate, $\text{Ca CO}_3$ .....	27.21
Calcic sulphate, $\text{Ca SO}_4$ .....	1.46
Magnesian carbonate, $\text{Mg CO}_3$ .....	20.33
Magnesian sulphate, $\text{Mg SO}_4$ .....	0.55
Iron bisulphide, $\text{Fe S}_2$ .....	4.31
Alumina, $\text{Al}_2\text{O}_3$ .....	1.61
Phosphoric anhydride, $\text{P}_2\text{O}_5$ .....	0.
Aluminic silicate, $\text{Al}_2\text{O}_3 (\text{SiO}_2)_3$ .....	22.75
Ferric silicate, $\text{Fe}_2\text{O}_3 (\text{SiO}_2)_3$ .....	trace
Silica, $\text{SiO}_2$ .....	16.48
Bitumen, water and loss.....	1.63
Sum.....	100.00 %

[Sum is really 100.75%. Error somewhere.]

(3.) *Erze*. These are all richer products which are furnished in different sizes (crushed, sifted or stamped), and are distinguished as rich or poor "*Erze*" (literally ores). The content varies between two and thirty per cent. of quicksilver and over. The average content of the "*ores*" worked during the last three years was, viz:

1877.....	9.69%
1878.....	7.52 "
1879.....	9.48 "

The composition of the average of the "Erz" product for the year 1878 was, according to the analysis of Assayer E. Teuber, viz:

Mercuric sulphide, $\text{HgS}$ .....	8.58 %
Mercurous chloride, $\text{Hg}_2\text{Cl}_2$ .....	0.22
Basic mercuric sulphate, $3 \text{HgO}, \text{SO}_3$ .....	trace
Ferrous carbonate, $\text{Fe CO}_3$ .....	4.27
Calcic carbonate, $\text{Ca CO}_3$ .....	14.71
Calcic sulphate, $\text{Ca SO}_4$ .....	2.42
Magnesian carbonate, $\text{Mg CO}_3$ .....	4.20
Magnesian sulphate, $\text{Mg SO}_4$ .....	1.11
Double iron sulphide, $\text{Fe S}_2$ .....	5.09
Alumina, $\text{Al}_2\text{O}_3$ .....	1.30
Phosphoric anhydride, $\text{P}_2\text{O}_5$ .....	trace
Aluminic silicate, $\text{Al}_2\text{O}_3 (\text{SiO}_2)_3$ .....	15.82
Ferric silicate, $\text{Fe}_2\text{O}_3 (\text{SiO}_2)_3$ .....	20.18
Silica, $\text{SiO}_2$ .....	17.64
Bitumen.....	3.97
Water and loss.....	0.49
<hr/>	
Total.....	100.00 %

The mine product is conducted by means of the horse road over a platform scale in trains of two cars with a load of thirty metrical centners; the Griese going to the ore magazine, the Stufen directly to the charging floor of the shaft furnaces.

The samples taken from Griese and Stufen are conducted by a road on to the roof floor of the sample room and deposited at the chute, crushed by rolls and then reduced by dumping on the reduction cone. The "ores" come directly to the assay office for preparation.

The determination of the quicksilver content is made, as stated, by means of the known Eschka's crucible assay with a gold cover with the addition of iron filings and minium.

The treatment of the three above named species of ores varies according to the system of the furnace used and according to the process itself.

While, by far the greatest part of the product, Stufen, Griesse and also a part of the Erze, are treated in roasting furnaces, of which the first variety is treated in the shaft furnaces, the rest in flame (reverberatory) furnaces, (here called "horizontal," to distinguish them from the shaft roasting furnaces); on the other hand, the largest part of the Erze are treated in muffle furnaces.

The decomposition of the cinnabar, in which form most of the quicksilver occurs, results, in the first system, through the action of the oxygen of the air, by which means the sulphur is changed into sulphurous acid, ( $\text{HgS} + 2\text{O} = \text{Hg} + \text{SO}_2$ ) and the quicksilver unoxdized volatilizes; in the latter system, through the action of the addition of quicklime, by which means sulphide of calcium and gypsum are formed, (thus,  $4 \text{HgS} + 4 \text{CaO} = 4 \text{Hg} + 3 \text{CaS} + \text{Ca SO}_4$ ), while the quicksilver becomes free and distils over at  $360^\circ \text{C}$ .

The products of the treatment of the ore are :

- (a) Metallic quicksilver.
- (b) Soot (Stupp), a mixture of quicksilver in more or less fine condition, chloride and sulphide of quicksilver, quicksilver oxide, flue dust and various distillation products of the ore, as well as products of combustion of the fuel.
- (c) Rich rubbish from the masonry and wall scrapings.
- (a) The quicksilver, without further refining, which its purity renders unnecessary, goes directly to the bottling room.
- (b) The soot is first treated mechanically, by which means most of the quicksilver is extracted and the residues from the press, together, also, with:
- (c) The rich rubbish from the masonry and wall scrapings are added to the furnace charge.

The working of the Griesse, which forms the larger part of the yield, is undertaken, as already stated, in reverberatory furnaces, of which Idria possesses twelve Alberti furnaces, of which ten are built according to the original model and two are provided with hearth heating. The work is the same at all the furnaces. These furnaces, constructed as roasting furnaces for continuous operation, are united in pairs as double furnaces, and have a gently inclined hearth 4.1 m. long 2.2 m. broad,

and the back part of the arch bears the charging funnel, which has a definite capacity, and in front the hearth is bounded by the discharge opening (called Brandgasse). The fire-place (plain grate), is at the side, the working door being brought on the front side, while at the back the flue opening leads into a flue dust chamber (the fire chamber). The Brandgasse stands beneath, with a discharge arrangement of cast-iron, closed by means of a flap, and holds exactly one charge.

From the hearth the vapors enter the fire chamber and circulate first through iron condensation tubes of 950 m. m. diameter, then through masonry condensation chambers; from these they are conducted into the underground flue system, then into the large condensation chambers, and then into the central chimney.

The iron condensation pipes are cooled by the dripping of water.

The furnaces with hearth heating are distinguished particularly by the construction of the hearth bottom and the arrangement of the fire-place in connection therewith. In these furnaces the flame passes from the back part of the hearth beneath its bottom, by means of a canal system, to the front part, here passes upwards and spreads over the charge from above. The hearth bottom heating contributes decidedly to thorough roasting; in other respects the motion of the flame under the hearth bottom, from the colder to the hotter portion of the charge, is not quite perfect, though at the same time the old furnaces, when carefully worked, furnish completely satisfactory results. This is best seen from the fact that the average of the residues for the year 1879 show an average of 0.001 per cent. of quicksilver.

The work at the reverberatory furnaces is entirely similar to that of ordinary roasting work.

These furnaces work in twenty-four hours, on an average, sixty-five metric centners of Griese, with a consumption of about three cubic metres of wood of mixed varieties, or 600-700 kg. brown coal, and were, during 1879, in operation 3,769 days. This gives for each furnace  $314\frac{1}{2}$  working days.

The force for serving these twelve furnaces includes for each eight hour shift twelve chief roasters for heating, drawing forward, turning, charging and discharging the burden, also for inspection and

maintenance of the condensation; one chief brakeman and two assistants for running off the residues, and three chargers for charging the ore hoppers; then, for all three shifts together, seven car-men to bring Griesse to the furnaces.

In consequence of the introduction of a premium for correct working, the number of laborers required has been considerably reduced, as in 1879 only sixty-one men, as against eighty-one in 1877, were required.

At the reverberatory furnaces the condensation tubes and chambers are swept three times yearly and the collected quicksilver and soot taken out, while at the time of shutting down, during the month of August, not only are the common flues and chambers swept, but also the greater repairs are undertaken.

The soot thus obtained goes first to the presses, while the various other products containing quicksilver—flue dust, scrapings and masonry—are taken directly to the furnaces.

The quicksilver content of the reverberatory residues was found by the official investigating commission, in 1873, to be 0.3 per cent., but in the year 1877 to be only 0.006 per cent.

According to the analysis of the chemical expert, Prof. Oser of Vienna, of a sample taken from one of the residues of the Alberti furnace, the following results were obtained:

Insoluble in Hydrochloric Acid.	{	Mercuric Sulphide.....	0.007 %
		Ignited Residue.....	26.680
		Carbonaceous Residue.....	1.820
		Silica.....	1.410
Soluble in Hydrochloric Acid.	{	Alumina.....	3.700
		Sulphide of Iron.....	0.050
		Ferric Oxide.....	2.333
		Calcic Carbonate.....	25.180
		Sulphuric Acid.....	2.920
		Lime.....	5.840
		Calcic Sulphide.....	0.050
		Magnesian Carbonate.....	29.960
Total.....			99.950 %

In the reverberatory furnaces there were in 1879, worked of ore and material from the works the sum total of 246,412 met. cr.

The content of this in quicksilver from ore and products containing quicksilver was 2,022 met. ctr.

The actual yield for quicksilver, and products containing quicksilver, was quicksilver, 1884 met. ctr.

Loss of Hg., 138 met. ctr.

The percentage lost was therefore 6.82 per cent.

The working of ores in the Alberti furnace occurred only exceptionally as a make shift during the years 1877 and 1878, and consequently the time of roasting could be lengthened according to the content of the quicksilver in the ore.

The working of the Stufen is undertaken in the shaft furnaces and the works possesses two systems of these:

1. The four new iron-clad shaft furnaces, Nos. I. to IV.
2. The three old iron-clad shaft furnaces, Nos. V. to VII., which, together, make up the shaft furnace plant.

The four new iron-clads built in 1878-79, are constructed as vertical shaft roasting furnaces; they have a common sheathing and rest on a bottom plate upon a foundation 0.9 m. high, 6 m. wide and 17.5 m. long. The sheathing is bound together with screws and is cemented tight with iron cement. It contains masonry so arranged as to form four furnace shafts, each 2.25 metres long, 1.75 metres wide, which are separated from each other by masonry one metre thick. The furnace walls descend vertically 4.25 metres from the throat and then contract for 2.75 m. to a section 2.25 m. long and 1.10 m. broad. At a height of three metres above the bed plate there lie at each furnace front two, hence four fire-places, and beneath these the corresponding four ash pit openings.

The fire-places have step grates, but can, by taking away the step grates and replacing them by flat grates, be worked as plain grates, or they may be used so as to feed the fuel in at the top by closing up the fire bridge opening with masonry.

The charging is effected by means of the cup and cone apparatus placed beneath a cover with a water valve. The vapors are removed by

means of three cast-iron pipes which cross the furnace and are provided with side openings. The pipes have a 470 m. m. interior diameter; on to these are fastened the condensation pipes which have the same diameter and run in triplets from each furnace. A part of these tubes stand in water baths in which the cooling water is constantly renewed. The tubes lead into masonry chambers whose walls are protected from the penetration of the quicksilver by asphalt coats, cement plastering and wooden linings, and whose floor is made of asphalt plastering upon a beton foundation. After these condensers above ground come small subterranean chambers which are connected by flues with the main canal.

When in full operation, each hour two cars of four each or together of eight metrical centners are taken directly by the residue cars and wheeled away, and at the throat each hour also two cars of four metrical centners each are charged.

Instead of flaming fuel (wood or brown coal), charcoal charged in with the ore, may be used to good advantage. With brown coal experiments were recently conducted.

The distillation products, soot, quicksilver, etc., are conducted from the tubes into collecting vessels from which the quicksilver is allowed to run out and the soot scraped out.

The new shaft furnances are arranged for an output of 192 metrical centners per furnace per twenty-four hours, or all told 768 metrical centners, and required in the first campaign in 1879 in twenty-hours in fuel: 3.281 r. k. m. mixed wood with plain grate firing; 7.715 metr. centners brown coal with step grate firing, or 1.827 cub. m. charcoal if charged with ore in layers, which figures during the present campaign, have been considerably diminished in consequence of the more regular working of the furnance.

The shifts are here also changed every eight hours and consists in the morning and day shifts of two chief firemen, two foremen, two firemen, two helpers, six chargers and four residue wheelers, while on account of the nearness of the place where the waste is dumped at night, the furnace men themselves are required to attend to the waste.

The old shaft furnaces, Nos. V. to VII., of which No. V. was first used in 1871, and Nos. VI. and VII. in 1876, are iron-clad shaft furnaces with a circular interior cross section.

The furnace shaft possesses an interior diameter at the throat of 1.9 m., and for a distance 4.10 m. below, it runs cylindrically and contracts from there on to the furnace bottom at a height of 1.41 m. conically to a diameter of 1.25 metres. The height from the floor of the works to the throat amounts to 8.2 m.

The three fireplaces are arranged about the shaft symmetrically, and beneath these are placed the ash pit openings in such a manner that a space (Brandgasse), is produced where the ore which has been drawn may cool, and may also warm the air which enters for combustion.

The construction of the three furnaces is, with slight changes, identical; on the other hand, the condensation system of No. V. is different from VI. and VII.; in the first are, namely, iron leg tubes of 470 m. m. inside diameter, which leads below into vessels for collecting soot, as also two small chambers of stucco on a wooden frame; in the latter are standing tubes of 950 m. m. interior diameter, which likewise stand in vessels to collect the soot, and finally end in small condensing chambers of masonry. The first two sets of tubes near the latter furnace are of cast-iron; the lower sets, on the contrary, of stone-ware. Both the leg tubes and the standing ones are cooled by water dripping upon them.

In regular operation, furnaces of this construction put 144 metrical centners through per day, and required, in 1879, 2.877 r. k. m. of mixed wood fuel, or 1.75 r. k. m. charcoal per working day.

The worked out residues of the shaft furnaces are dumped over the bank and contained, according to the investigation of the official commission in 1873, 0.1 per cent. of quicksilver; in 1877, however, only 0.002 per cent.

The sample taken by Prof. Oser, fortunately, on the last commission, shows by his analysis that the shaft furnace residues have the following composition:

Insoluble in Hydrochloric Acid.	{	Mercuric Sulphide.....	0.0023 %
		Ignited Residues.....	20.05
		Carbonaceous Residues.....	0.80
		Silica.....	1.25
Soluble in Hydrochloric Acid.	{	Alumina, $\text{Al}_2\text{O}_3$ .....	6.54
		Iron Sulphide, $\text{FeS}$ .....	0.16
		Ferric Oxide, $\text{Fe}_2\text{O}_3$ .....	1.58
		Calcic Carbonate, $\text{CaCO}_3$ .....	25.88
		Calcic Sulphate, $\text{CaSO}_4$ .....	1.75
		Calcic Sulphide, $\text{CaS}$ .....	0.22
		Calcic Oxide, $\text{CaO}$ .....	11.63
		Magnestic Carbonate, $\text{MgCO}_3$ .....	29.91
Total.....			99.7723 %

The labor at the old shaft furnaces per eight-hour shift is as follows: One chief fireman, one helper, one charger and one slag man, when the dump is at great distance.

The duty of the labor, including the slagmen, for the combined shaft furnace system for the year 1879, during which time the old furnaces yielded, on an average, 117.07 metrical centners, and the new ones, on an average, 158.73 met. cent., was 10.64 met. cent. per man per shift.

During this year, 141,289 met. cent. of Stufen were worked with a quicksilver content of 594 met. cent., and out of this 499 met. cent. of quicksilver was produced, which amounts to a loss of 15.96%. [15.99%.]

The third class of material, the so-called "Erze," are generally treated in the (Fortschauflungs) continuous reverberatories, or in the muffle furnaces, and only exceptionally in the Alberti furnace.

The continuous reverberatories treat generally only sifted or crushed ores of somewhat coarser grain and less richness. These furnaces are constructed as iron-clad reverberatories after the manner usual in metallurgy for such continuous furnaces, and have hearth-heating attachments. They have an exterior length of 8 m., and 3.5 m. external breadth and 2.2 m. exterior height, and an active hearth surface of 13.2 square meters with a breadth of 2.2 m., and a length of 6 m. Along one of

the long sides are three working doors, along the front side are two; the fire-place lies beneath the first hearth division, the flames play upon the whole bottom, enter the draw pit and rise and pass with the products of distillation over the whole layer of ore into the condensation system. This consists of a cast-iron chest-like condenser of three lines of up and down leg tubes of 470 m. m. interior diameter, which are connected at the bottom by collecting vessels, and of two larger condensers which communicate with the subterranean flue system.

The out-put varies, according to the content of the ore, from twenty-five to forty met. cent. per twenty-four hours, which is accomplished by a wood consumption of 3 rkm. of mixed sorts. For direct management of the furnace are placed one chief fireman and one assistant.

In the year 1879 there was treated in this furnace 11,201 met. cent. with a quicksilver content of 960 met. cent., and there was produced 885 met. cent. quicksilver, which amounts to a loss of 7.86%. [7.81%.]

The muffle furnaces treat the finely powdered ore, which is mixed with quicklime, made into bricks, and treated without contact with air.

The Idria muffle furnaces, six in number, each containing two muffles, were developed from the muffle furnace of Ure, common in the Rheinpfalz; but the present system is superior to the original ones, on account of the numerous ingenious devices for protecting the workman against vapor and dust. The cast-iron muffle is 2.240 m. long, 0.690 m. wide and 0.34 m. high; has a flat bottom, a gently arched top, and behind, a cover through which the discharge tube enters, and which is fastened in with iron cement, and is in front closed by a cover fastened by means of cross-piece and two wedges. Each pair of such muffles lies symmetrically over a fire-place and inside of an arched-over masonry space, is surrounded by the flames, and so forms a furnace. Each pair of furnaces has a common chimney for the removal of the furnace gases.

The condensation consists of a system of vertical tubes, which stand in a vessel of water and may be cleaned of distillation products by means of movable discs.

The ore bricks are made from a mixture of finely powdered ore and dust of quicklime, (15 per cent. to 10 per cent. Hg.) in moulds 25 cm. long, 13 cm. broad, and 2.25 cm. high; these are dried in a rack.

From a metrical centner of ore are made from seventy-six to eighty ore bricks. Each muffle holds six rows of eighteen bricks, each placed on edge, which corresponds to a charge of 135 kg.

When the charge is burned out, which takes, according to the content, from four to six and more hours, the charge is drawn into the dumping canal and the muffle is charged with the previously prepared brick charge.

The richer the charge to be worked, the oftener the condensation tubes must be cleaned by drawing the cleaning disc through them, and the condensed quicksilver must be removed.

The consumption of fuel per furnace per twenty-four hours is 1.8 kbm. mixed wood, or 360 kg. brown coal. To the service of six muffle furnaces for each eight-hour shift belong one chief fireman, one fireman, five helpers, when the charges are drawn every four hours; if they are drawn only every eight hours, one chief fireman, one fireman, two helpers.

In the year 1879 these muffle furnaces treated in twenty-four hours 8.21 met. centners per furnace and worked 2,469 shifts, so that, per head and shift, 3.28 metric centners were treated.

The residues were dumped into the waters of the Idriza, and contained, according to the investigation of the commission of 1877, in one metrical centner, 0.011 per cent. quicksilver.

An average sample taken at this time was, according to Dr. Oser's analysis, composed as follows:

Insoluble in Hydrochloric Acid.	{	Mercuric Sulphide, HgS.....	0.015 %
		Ignited Residues.....	39.330
		Carbonaceous Residues.....	5.710
		Silica, SiO <sub>2</sub> .....	2.400
Soluble in Hydrochloric Acid.	{	Alumina, Al <sub>2</sub> O <sub>3</sub> .....	6.110
		Ferrous Sulphide, Fe S.....	0.820
		Ferric Oxide, Fe <sub>2</sub> O <sub>3</sub> .....	3.740
		Calcic Carbonate, CaCO <sub>3</sub> .....	8.540
		Calcic Sulphate, CaSO <sub>4</sub> .....	4.450
		Calcic Sulphide, CaS.....	1.760
		Calcic Oxide, CaO.....	8.800
		Magnestic Carbonate, MgCO <sub>3</sub> .....	18.290
Total.....			99.965 %

In the year 1879 were treated 8102 met. cent. Erze with a content of 870 met. cent. quicksilver, from which a yield was obtained of 792 metric cent., the loss being 9.01 per cent. [8.979 per cent.]

The furnace gases and distillation products of the shaft furnaces, reverberatory furnaces, and continuous reverberatory furnaces, as well as the distillation products from the muffle furnaces, are conducted first through the condensation system belonging to each furnace where their content is mostly precipitated. The part which is not yet condensed is conducted through the underground canal system common to all the furnaces into the large condensation chambers, where the greater part remaining is condensed, and only the uncondensable residues pass out at the chimney.

The entire condensation plant includes, consequently, the following parts:

1. The collecting canal from the single furnaces which leads to the chambers.
2. The four condensation chambers.
3. The smoke filtering chambers.
4. The smoke canal which climbs the mountain side and leads to the central chimney.

The combining flue possesses an average inner height of 1.58 metres, a width of 0.8 m. to 0.95 m. and a total length of 570 m.

The four condensation chambers which are placed near each other have each a height of 3.15 m., a breadth of 2.825 m. and a length of 50 m.

At the last chamber is placed within a building a double smoke filter made of a coarse wooden sieve which is filled with chips, and whose single parts may be removed by sliding; through this all the smoke must pass before entrance into the chimney canal.

The chimney itself has an inner diameter of 1.305 metres, and is 14.3 m. high.

The entire cubic content of the condensation system is as follows:

Of the chambers.....	1780	cub. m.
“ “ canals.....	830	“ “

---

Total.....2610 cub. m.

For regulating the draft a fire place is built in the chimney canal.

The gases escaping from the chimney have, according to the investigation of the official commission, a velocity of 1.4 m. per second, and there passes, therefore, through a cross section of 1.331 sq. metres, a volume of 1.8634 cub. m., or 1863 litres, and in twenty-four hours 160,997,760, or, in round numbers, 161 million litres of gas pass through the chimney. There was found in 1,000 litres of chimney gases .00356 grammes of quicksilver, hence in twenty-four hours there will escape 573.16 g. of quicksilver. [About 1.26 lbs.] There was contained in the chimney gases 0.0695 per cent. SO<sub>2</sub>, by volume, or in 1,000 litres gas 1.72 grms.

The investigation made by Patera in 1876 of a sample of 1816 g. of soot from the chimney gases gave: 686 g. quicksilver of which

1816 g. Soot	$\left\{ \begin{array}{l} 133 \text{ g.} \dots \dots \dots \text{ was in form of salts} \\ 57 \text{ g.} \dots \dots \dots \text{ " metallic} \\ 496 \text{ g.} \dots \dots \dots \text{ " cinnabar} \end{array} \right\}$	686 g., Hg.

That the arrangement of the underground canal and the large chambers act advantageously in retaining considerable quantities of quicksilver from vapors may be best seen from the results of cleaning these underground spaces.

Thus the production for 1879 from sweepings, viz:

	Soot.		Hg.
From whole Flue System to Chambers.	8,590 kg.	@ 34.26 %	= 2943 kg.
" Chamber No. 1	3,850 "	" 24.50 "	= 943 "
" " 2	3,362 "	" 9.30 "	= 312 "
" " 3	3,417 "	" 9 "	= 307 "
" " 4	3,374 "	" 8 "	= 269 "
" Chimney Canal and Chimney...	2,773 "	" 7.20 "	= 200 "
Total Soot	25,366 kg.	with	4974 kg.

From this also the steady diminution of the quicksilver content in consequence of the condensation that has taken place is clearly to be seen.

Upon the composition of this soot the following analyses may be given:

(a) By Bergrath Patera at the Imp. Mining and Metallurgical Laboratories at Vienna.

(b) By Assayer Teuber at the present laboratory.

(c-a) The analysis of soot samples for the years 1876 and 1877, made by Professor Dr. Oser, of Vienna.

#### CHIMNEY SOOT.

(a)	Metallic quicksilver.....	6.42%	= 6.42%	Hg.
	Mercuric sulphide.....	2.20	= 1.89	"
	Mercuric sulphate.....	13.17	= 9.54	"
	Mercurous chloride.....	1.80	= 1.53	"
	Sulphuric acid.....	4.80	<u>19.38%</u>	Hg.
	Magnesia.....	1.10		
	Lime.....	1.20		
	Ferric oxide and alumina.....	0.80		
	Calcic sulphate.....	6.30		
	Basic ferric sulphate.....	0.40		
	Soot and resinous sublimates.....	29.40		
	Ignition residues.....	3.80		
	Water.....	26.50		
			<hr/>	
			97.79%	[97.89]
(b)	Metallic quicksilver.....	3.12%	= 3.12%	Hg.
	Mercuric sulphide.....	31.10	= 26.60	"
	Mercuric sulphate.....	10.80	= 7.90	"
	Ferrous ".....	6.02	<u>37.62</u>	" Hg.
	Magnesian ".....	7.50		
	Sodic ".....	1.24		
	Ammonic ".....	0.54		
	Silica ".....	2.20		
	Organic sub. sol. in ether.....	5.		
	Carbon.....	19.80		
	Water, etc.....	10.30		
			<hr/>	
			97.65%	[97.62]

(c)	Water.....	19.30%
	Hydrocarbons sol. in ether.....	4.17
	Carbon.....	18.55
	Sulphuric acid.....	21.65
	Sulphur in cinnabar.....	2.18

## QUICKSILVER,

In salt form, sol. in ether.....	0.03	} 14.62% Hg.
In " " " " H. Cl.....	0.55	
Metallic.....	0.43	
Mercuric sulphide (cinnabar).....	13.61	

## SOOT FROM CONDENSATION CHAMBERS OF REVERBERATORY FURNACES.

(d)	Water.....	31.55 %
Extract from Nitric Acid	{ Quicksilver that may be pressed out.....	40.95
	{ Sulphuric Acid.....	1.24
Extract from Bromine	{ Quicksilver metal and as salts.....	9.15
	{ Sulphuric acid.....	0.15
	{ Sulphuric in mercuric sulphide.....	0.59
	{ Quicksilver in " ".....	3.73
	Carbon.....	3.31
	Ash ingredients.....	9.33
		<hr/> 100.00 %

The amount of soot (as well as the quantity of quicksilver in the soot, which, as may be seen from the four analyses above, varies very much,) depends not only on the kind of ore and its richness, but also on the kind and quality of the fuel and upon the proper management of the treatment (draft, etc.).

The soot coming from all the single cleanings, with the exception of the poor chamber soot, is first subjected to a mechanical treatment; the so-called "presses" for the removal of the quicksilver and the residues which still contain quicksilver, are added to the roasting charges.

There are three soot presses, similar to clay-kneaders; one large, of 1.25 m. diameter and 0.52 m. high, and two small, of 0.7 m. diameter

and 0.52 m. height; their axles being set in motion by means of a five horse-power water wheel.

In an eight-hour shift there are treated in the large or two small presses, in five charges, (of fifteen or thirty-six vessels), 170 vessels of soot, from which one has left 450 to 550 kg. of soot mixed with 15 per cent. lime.

The labor for each shift consists of one foreman and three assistants.

The quantity of soot from all sources amounted, in the year 1879, to:

SOOT FOR 1879.

Reverberatory furnaces.....	1782	met. cent.....	23.65	% Hg.
Continuous reverberatory furnaces..	179	" "	35.55	"
Shaft furnaces.....	376	" "	32.21	"
Muffle furnaces ore work.....	113	" "	19.32	"
Muffle furnaces soot work.....	315	" "	18.49	"
		<hr/>		
		[2765	" "	304.15 Tons]

The pressed soot, as well as that which is not worth pressing, is burned in the muffle furnaces, in round clay vessels which hold about 4 kg. A muffle holds, as a rule, twenty-one vessels=84 kg. The time of burning a charge and the number of men required at a furnace depends on the richness of the product.

There were worked per furnace day, per pair of muffles, 3.64 metr. centners of soot, a duty per man and per shift of 2.146 met. centners.

In the whole there was treated 2,324 metrical centners of material from the works—soot, flue dust, etc.—with a total content of 862 met. centrs. quicksilver, which yielded 817 met. centners quicksilver, the loss being 5.16 per cent. [5.22 per cent.].

The quicksilver is packed in either wrought-iron bottles with a screw stopper, holding 34.5 kg., or else in sheep-skin bags, holding 25 kg., and are packed in the store room. Each pair of bags are packed in a cask, and the quicksilver comes into the market either in this shape, or else in the above-mentioned flasks.

In the year 1879 there were treated, in all, 409,329 met. centners of ore and metallurgical products, with a quicksilver content of 1.296 per cent., containing 5,308 metrical centners of quicksilver, and there were produced 4,877 metrical centners of quicksilver, with a loss of 431 metrical centners, or 8.1206 per cent. [8.1198 per cent. = 8.12 per cent.].

The works have, with the exception of nine foremen and four watchmen, no regular staff of workmen, but these are taken from the body of miners. There are on the average 150 to 180 men in use at the works, and these are changed four times a year, and, when necessary, oftener.

## B.—VERMILION MANUFACTURE.

In the oldest times of the existence of the present works, vermilion was manufactured. In the beginning it was merely pure, pulverized, cinnabar ore, then later it was a product made by sublimation from this substance; and there were formerly other works for vermilion manufacture than those for quicksilver production. When the Venetians and Dutch began to produce better wares, the production here sank steadily.

The researches of Christofoletti, in 1681, and of Baron Richtenfels, in 1726, for the improvement of Idrian vermilion, met with as little success as those of some Venetian women—1740–1741—who had lost their husbands in the Venetian works, and had offered themselves to manufacture vermilion according to the Venetian method.

After Hacquet had strongly urged the manufacture of vermilion, Oberhüttenmeister Ignaz v. Passetzký succeeded, with the Dutchman Güssig assisting him, in making beautiful cake cinnabar in 1782, and in 1785 vermilion also, in the newly built works on the right bank of the Idriza.

In 1796 Oberhüttenverwalter (Manager of Works) Leopold v. Passetzký introduced the sublimate and precipitate manufacture, but it was abandoned as unprofitable in 1824.

The many foreign attempts to manufacture vermilion in the wet way caused similar ones here, as those of Fabriks-Controllor Rabitsch in 1838, and later of Hüttenverwalter M. Glowacki, which brought larger amounts of the vermilion so manufactured into the market. Still this manufacture came to no full development, and became forgotten until, finally, in the years 1877 and 1878, experiments led to its being discontinued on account of costliness and uncertainty of the method. A new set of experiments in 1878 and 1879, by Assayer E. Teuber and Director of Works (Hüttenverwalter) H. Langer, under the direction of the Imp. Agricultural Ministry, led to favorable results. A new manufactory, set in operation in 1880, furnishes three sorts of vermilion manufactured in the wet way.

The arrangements of the works for the manufacture of vermilion in the dry way consist of:

One sulphur stamp battery.

One amalgamating plant with eighteen small barrels, both pieces of apparatus being driven by a two-horse-power water wheel.

Four sublimation furnaces, each with six retorts of cast-iron.

Four vermilion mills, each driven by a water wheel of 2.5 horse power.

Kettles and vats for heating, digesting and refining the ground cinnabar.

One drying hearth.

The preparation of vermilion, as an article of commerce, falls into several separate operations, viz:

1. Almalgamation; *i. e.*, preparation of the raw Mohr.
2. Sublimation; *i. e.*, preparation of the cake cinnabar.
3. Grinding of the cake cinnabar, refining and drying of the vermilion.

For the preparation of the raw Mohr for each charge of eighteen kegs there are taken 80.64 kg., powdered and sifted sulphur, and 423.36 kg., of quicksilver.

The amalgamating kegs each contain twenty-eight kg. of the charge, and are given intermittent rotating motion by a rack and pinion driven by a water wheel. After, on an average of two and three-quarter hours, the amalgamation is complete and the raw Mohr is taken from the casks.

For the sublimation four furnaces are used, each with six pear-shaped cast-iron retorts of considerable thickness. Each is charged with fifty-eight kg. of Mohr, the mouth covered with a loosely-placed sheet-iron helmet, the furnace being slowly fired; the combination of the sulphur and the quicksilver then results in about fifteen minutes, with a detonation. As soon as this operation (*das Abdampfen*) is over, a clay helmet is placed over the retort and the firing is increased so that after two hours and twenty minutes, the excess of sulphur evaporates from the tube. The tube and condenser are now added (*Stückperiode Cake-period*) and luted, then the firing is still more urged, whereupon the cinnabar volatilizes and deposits itself upon the glazed earthenware condensation apparatus (tube, helmet, etc.). After four hours the sublimation is complete, and there is furnished by the helmet 69 per cent., by

the tubes 26 per cent., by the condenser (Vorlage) 3 per cent., and by scrapings 2 per cent. cinnabar.

The grinding of the cake cinnabar takes place in four mills driven by an undershot water wheel. These mills have a fixed under and movable upper stone, and the grinding is done with water. The vermilion which leaves the spout and runs into glazed clay vessels has a temperature of about  $38^{\circ}$  C., that of the air being  $15^{\circ}$  C. The mill-stones make forty revolutions per minute, and after each passage of the charge are placed nearer together. There are three sorts of vermilion manufactured.

HR: high-red vermilion

DR: dark-red       “

C: Chinese         “

From the mill the cinnabar undergoes the refining, which consists in digesting the cinnabar in potash lye.

As soon as a cinnabar charge has settled in the refining vat, the solution is drawn off and the cinnabar is washed with water until the water runs off perfectly clear. The pulpy mass is placed in glazed drying vessels and dried.

The dried vermilion is then sifted and packed.

The greater part by far of the vermilion, as well as cake cinnabar, is packed in tanned sheepskin in packages of 12.5 kg., of which a pair are placed in a wooden keg. Only a small part of the vermilion comes in boxes of 0.5 kg., which again are packed in larger boxes of twenty-five and fifty kg.

## V.

### Production and Profit.

*By M. V. Lipold.*

There are only few and isolated facts regarding the amount of the quicksilver production in the first century of the mining operations, as also of the selling price of quicksilver and vermilion, which latter was only the natural cinnabar won from the rich and pure ore.

From old documents it appears that in the year 1525, 1340 metr. centners of quicksilver and 224 metrical centners vermilion at thirty-six florins per metrical centner, were sold. In the later years (1530 to 1580) the quicksilver production amounted yearly to 560 metrical centners, in the year 1566, the price was 125 florins per metrical centner.

At the beginning of the seventeenth century the production of quicksilver increased, and beginning with the year 1612 amounted for some years to 1680 metrical centners yearly; in the later years it averaged 1120 metr. centners.

The quicksilver price varied between 80 and 180 florins per metric centner.

In the first half of the eighteenth century, and till 1785, the quicksilver production varied between 840 and 1800 metr. centners.

The quicksilver price for 1741 is given at 326 florins per metr. centner.

In the year 1785 the Austrian government made a contract with Spain to furnish during six years, yearly, at least 4,480 metrical centners to Spain. In 1791 this contract was renewed for six years longer, at the yearly rate of 5,600 metr. centners.

The quicksilver production at the time of this Spanish contract was the largest which the mining work has yet reached. This was under the special management of Gubernialrath Josef v. Leithner.

From the tabular statement, Table II, upon the production, price and profit in the last century, is to be seen that, after the end of the Spanish quicksilver contract, during which the quicksilver production rose in a single year to 6,100 metr. centners, the production steadily diminished until, just before the present time, it amounted, on the average, yearly, to 1,700 metrical centners in round numbers.

Since the year 1867, when the mining operations took on more activity, the quicksilver production has notably increased, and amounted in the last decade to an average of 3,770 metr. centners yearly, and was the highest in 1879, being 4,193 metr. centners for that year.

The total production of the last century was, with the exception of four years, whose production is unknown, 210,059 metrical centners.

The Table II. gives, also, in column *a*, the amounts of ore which have been worked since the year 1786 at the works, while column *b* gives the average quicksilver content of the ore.

One may see from this compilation that, at the time of the Spanish contract, the yearly production of ore which was worked was fifty to eighty thousand metr. centners, and that this averaged from eleven per cent. to sixteen per cent. of quicksilver. After that time the yearly amount of ore treated considerably diminished, and amounted in the next two decades to scarcely twenty or thirty thousand metrical centners per year, and that, also, the richness of the ore was less, varying still, however, between five per cent. and ten per cent.

Since the year 1836, however, four per cent. ore has been taken, and, in consequence, the amount of ore worked has increased per year to between thirty-four and forty thousand metr. cent.

With the introduction of the horizontal reverberatory furnaces, by Bergrath Alberti and Manager of Works Glowacky, begins a new era, that of large production. One may see from columns *a* and *b* of Table II. that from 1844 to the present time, there has been worked ore of an average content of only one per cent. to two per cent., and that in consequence the amount of ore worked increased, until in 1866 it reached an average of 170,000 metrical centners.

The increase of quicksilver production since the year 1867 was only in consequence of the treatment of larger quantities of ore in

consequence of the introduction of the shaft furnaces, and at the works, since the year 1868, annually, over 250,000 met cent. of ore have been treated, and in the year 1879, 406,000 metrical centners were treated.

From column *e* may be seen what great fluctuations the price of quicksilver has undergone during the present century. While, from 1820, for fifteen years, the price of quicksilver scarcely ever rose to the height of 200 florins per metrical centner, it rose in the next fifteen years far above 400 florins per metr. centner.

After 1852 the price again went down, and varied between 200 and 280 florins per met. centner.

In 1871 the price went up again, and the mine received for the sale of quicksilver the exceptional price of 639 florins per metrical centner in 1874. [On account of the assassination during a riot among the miners of M. Monasterio, the manager of the Almaden mine in Spain, which threw that mine out of production for the time.] Since this time the price has steadily gone down, and there was paid for quicksilver at Idria, during 1879, only 200 florins per metrical centner.

The prices given in column *c* are the average prices which were paid during the entire year named. How much the price varied in the course of a year may be seen from the fact that the lowest selling price in the year 1874 was 575 florins, the highest 767 florins per metrical centner, while the retail price reached 796 florins per metr. centner. In the year 1879, on the other hand, the lowest selling price was 189 florins, and the highest retail price was 279 florins per metr. centner.

The profits of the State mining work at Idria, which are given in Table II., column *f*, since the year 1814, vary, it is evident, according as the production and price were higher or lower.

The profits designated in column *f*, before the year 1868 have relation, not to the production, but to the sales for the year named, for while in some years less quicksilver was produced than was sold, in other years the reverse was the case. This is the reason that in some years a loss appears to be shown. Beginning with the year 1868, a new method of reckoning up was introduced, and in column *f*, Table II., from this year on, the amounts for each year are the profits really resulting from the quicksilver production.

This shows that the mining works at Idria have yielded a clear profit of over 1,000,000 florins in 1871, 1873, and 1874—in the last year nearly 2,000,000 florins, and also, in 1875, nearly 1,000,000 florins, a thing formerly never accomplished, and which, in the case of the first of these years, was due to the extraordinarily high prices of quicksilver, but which also results from working the whole body of the ore, which has been the case since 1868.

In the sixty-five years following 1814, the mining works at Idria have yielded the State a yearly average profit of 365,000 florins, or a total profit of 23,746,755 florins.

## VI.

### Buildings, Machinery and Communication.

*By Johann Onderka, Imperial Mining Counsellor.*

#### A. BUILDINGS.

The real estate possessions of the Idria Quicksilver Works have assumed in the course of years an extent which is hardly usual in mining works, particularly with regard to official and dwelling buildings, as it was necessary from the earliest times to arrange dwelling houses for the officials, and after some time for the increasing number of workmen.

The condition of these possessions of the works is as follows:

1. Offices and dwelling houses.

(a) The castle "Gewerkenegg." It contains the dwelling of the mining directory, of the chancery officials, of the porter and of a court servant; then the chancery of the mining directory, among which are included in the building the district court and tax office, and, finally, the product warehouse.

(b) Twenty-one dwelling houses, of which nine are for officials and twelve for workmen and servants, six of the number being built between 1872 and 1876.

(c) The office building, with the various sub-offices for the mine, in the basement story, the dwelling of the mining surveyor (Bergmeister) in the first story, and that of two servants in the roof story.

(d) The office of the metallurgical works, with quarters for two servants in the basement floor, and for office rooms in the first floor.

(e) The grain warehouse, with store-rooms for the steward and the offices of the quartermaster and controller.

(f) The Adler Gasthaus (Eagle Hotel), bought and rebuilt in 1752, with the cellars and bar in the basement, and rooms for guests in the first and second stories.

(g) The Crown Hotel, bought and arranged in 1778, one story high with seven different lodging and tap rooms.

(h) The parsonage, with dwellings of the dean and two chaplains.

(i) The new Public School of the Works, built in 1875-1877, with five classes for boys and four for girls, one industrial school for girls, one drawing room, one turners' hall, one music hall, one lace-making school, one school museum, one conference room, three teachers' rooms and one servants' dwelling.

(k) The apothecary building, with the drug store, office and laboratory in the basement, and dwellings for apothecary, assistants and school director in the first story and under the roof.

Besides these there belong to the works:

The shooting grounds on the Zemlja, with the shooting stand and bath-room in the basement, and a saloon in the first story.

The Works Theatre and the monument of cast-iron in the cemetery, in remembrance of the seventeen miners who lost their lives in the mine fire of 1846.

2. Manipulation buildings.

(a) Five shaft houses, with wheel-room and machine rooms.

(b) Ore dumping house for dumping material from the mine, near the Josefshaft.

(c) Powder tower for storing blasting powder.

(d) Two magazines for dynamite, the one for 1000 kg., the other for 50 kg. dynamite, with a high-pressure water tube-heating-arrangement.

(e) Sorting house, No. 1 contains a battery of twenty-five stamps for dry crushing, coarse and fine roll crushers, with a five horse-power movable engine, one rock breaker, one rotating and two band sorting tables; also two dumping chambers, each with three divisions and two sieves.

(f) Sorting house, No. 2 contains one dumping room with three divisions and a pair of sieves to each, and in the loft the dwelling of the sorting foreman.

(g) Metallurgical and factory buildings.

(h) Shaft furnace buildings.

- (i) Works for roasting ore.
  - (k) Works for roasting soot.
  - (l) Factory for making cinnabar in the wet way.
  - (m) Ore house with twenty-one chambers.
  - (n) Wooden works for the reverberatory furnaces.
  - (o) Assay office, built in 1872.
  - (p) Old bath-house at the works, built in 1869.
  - (q) New bath-house, built in 1878.
  - (r) Pottery for the manufacture of clay vessels used at the works and factory.
  - (s) Central chimney, with four condensation chambers, built in 1873.
  - (t) New sampling house, built in 1879, with a twelve horse-power motor, a ball and a mortar mill.
  - (u) New filter chamber with seventy-two filter frames, built in 1879.
  - (v) Smithy and coal bins with three horse-power turbine to drive the blower; one hammer driven by water power, and five smith fires.
  - (w) Mechanical workshop, containing in the basement three lathes, one drill, one shaper, one planer, one cupola furnace, one wind furnace, one spring hammer, a six horse-power turbine, and in the first story the locksmith shop.
  - (x) Turning and tube-boring shop, with three horse-power turbine and one circular saw.
  - (y) Carpenter and joiner shop, with the necessary work rooms, one wood planing and finishing machine and one band-saw.
  - (z) Material department with four magazines in the basement and a lumber room in the first story.
  - (z 1) Board, saw and store house.
  - (z 2) Brickyard in Leubentsch valley, with a kiln and drying house.
  - (z 3) Brickyard at Brusovse, with kiln and drying shed.
  - (z 4) Stable for three pair of draft horses, with harness room, men's room and hay loft.
  - (z 5) Stable at Brusovse for the horses of the freighters of the works.
- A new extension of the works for ten iron-clad, double-roasting, reverberatory furnaces is being built; it was begun in 1879.

### 3.—Grounds and Lands.

These have an area of 135.69 hectares, and consist partly of gardens, meadows and fields—which are rented out at a moderate rate to officers, servants and workmen—partly of pasturage, and unproductive spots used for the works.

### 4.—Water Conduits.

(a) Water ditch, which, with its stone dam and watchman's cabin, was already built in 1596. It is 3 km. 439.3 m. long, and was mostly lined with masonry between 1766 to 1770. It possesses an average flow of 0.75 cubic metres per second, and an available fall of 13.27 m., and furnishes an amount of power equal to 134 horse-power.

(b) Cast-iron water pipes, viz :

1. Water pipe through the Ignaz tunnel to the Franz shaft.
2. Water pipe from the Barbara water wheel discharge to the stamp battery.
3. Water pipe from the Barbara feld to the Josefi shaft (in the mine).
4. Water pipe from the ditch to the turbine in the boring works.
5. Water pipe from the discharge at the Theresia wheel to the discharge ditch.

6. The castle water pipe.

(c) Wrought iron pipes, viz :

1. Water pipe in the vermilion factory.
2. “ “ dwelling of officers of the works.
3. “ “ dwelling house No. 41–42.
4. “ “ from the castle to the new school house, and thence to the Eagle Hotel.
5. Water dam.

This is placed near the works and vermilion factory, for holding the water for power for driving the water wheels and turbines. There is a bridge over it.

## B.—MACHINERY.

In the beginning the hoisting was done by horse-power and the pumping by suction pumps. Since 1596 the hoisting and pumping have been done by brake wheels and pump-rod systems driven by water wheels. The water was brought in by the water ditch before mentioned.

Since 1847 pressure pumps instead of suction pumps have been used.

There are now in use at the five shaft houses the following pumping and hoisting machinery :

1. At the Ferdinand shaft.—One over-shot wheel, 14.22 m. diameter, with 40 horse-power, for driving five simple sets of pumps of 184.3 m. m., 210.7 m. m. and 250.1 m. m., and an extra pump of 184.3 m. m. This water power is capable of being used, by means of a belt, either for pumping or hoisting.

2. At the Theresia shaft.—Two double-acting plunger pumps of 237 m. m., which are driven by an over-shot water wheel of 10.85 m. and of fourteen horse-power. In the years 1879 and 1880 a Meyers hydraulic engine (*Wassersäulmaschine*) of forty horse-power was built. Besides, there is at the Theresia shaft a sixty horse-power low-pressure steam engine, which was, in 1870, arranged to drive the pumps when required. A tangential turbine is arranged, with a partial cut-off, to do the hoisting.

3. At the Franz shaft.—One "*Schwamkrug*" turbine of nine horse-power, which, when required, may be used for pumping.

4. At the Barbara shaft.—A water wheel twelve m. in diameter, to drive the 342.4 m. m. pump set, and a Kehrrod of 10.1 m. diameter, for hoisting.

5. At the Josefi shaft.—For pumping, three double-acting suction and lift pumps of 296.2 m. m. diameter, and two relief pumps of 171.1 m. m. and 184.3 m. m., which are driven by an over-shot wheel, 13.2 m. diameter and of thirty-three horse-power. For hoisting, a high-pressure engine of twenty horse-power was built in 1870 and 1871.

## C.—MEANS OF COMMUNICATION.

(a) From Idria outwards:

Until 1760 there existed only the bordering roads, and there were first built, in 1760 to 1765, the road to Oberlaibach over Veharse; in the year 1825, that over Raspotje to Sairach and Lak, as also that over Kluce to Schwarzenberg and Wippach, and in the years 1857 to 1859, the main road through the Sala ravine to Loitsch, a considerable portion of it being done by the Imp. Mining Company; and supplementary to this, a road from Godovic on to Schwarzenberg.

In consequence of the construction of a train roadway from Idria to Loitsch, the roads to Oberlaibach and over Kluce to Schwarzenberg have lost their original importance and have been, consequently, given up as district roads, and are maintained as community roads by the people of these districts.

(b) Within the town of Idria:

The communication here is effected partly by means of railroads, partly by wagon roads.

1. Railroads.

There are the following transportation roads:

(a) Mine tramways, 11 k. m., 200 m.

(b) Surface tramways.

1. Road for ore from the shafts to the sorting houses, 1 k. m., 202 m.

2. Road for ore from sorting houses to the works, 1 k. m., 459 m.

3. Network of roads at the works, 1 k. m., 526 m.

4. Roads for transporting wood, 1 k. m., 137 m.

Of these roads the horse road from the sorting houses to the works was introduced in 1851 and '52, and the rest only in the last two decades.

2. Roads in the works.—The roads and ways leading to the castle building, Josefi shaft, the works and the various manipulation buildings, are maintained at the cost of the Imp. Mining Co., although they serve for the most part for public use.

3. Bridges.—The main bridge over the Idriza, near Friedhof, as also all the bridges in the town of Idria, partly masonry, partly wooden, are maintained by the mine.

4. Stabling.—The teaming is for the most part done by private owners of draft animals, with whom there is arranged a uniform rate of tariff for hauling, but they cannot afford to confine themselves to the freight of the works, because they use their animals themselves for their farm work, so to meet the press of freighting three pair of work horses are kept in the stable.

## VII.

### Relations with Labor.

*By M. V. Lipold.*

As at the beginning of the mining operations in Idria, the vicinity was not peopled, foreign miners were introduced to work there, and even in the first years of 1510 to 1520, German miners from Carinthia and Salzberg wandered to Idria. The mine received thence the name German Idria, as distinguished from Idria in Tolmein, and maintains this designation in the popular mouth to the present day.

Even at the beginning of mining, the works were compelled to arrange a grain warehouse for the workmen, and from this soon developed the still existing commissary department. In the seventeenth century this now existing department was already created.

Also the reigning prince was interested in the welfare of the miners. Emperor Ferdinand I. founded the "Imperial Hospital" in 1853 at Laibach for workmen incapable of further labor from Idria and other mines in Krain. From this foundation resulted, in consequence, the now endowed "Hospital Foundation," or endowment, whose yearly income amounts to 2091.6 florins, which is annually divided by the mine directory into fifty-seven portions of 19 fl. 16 kr., 25 fl. 25 kr.; 44 fl. 71  $\frac{1}{4}$  kr. and 63 fl. 87  $\frac{1}{2}$  kr., which are awarded to broken-down miners no longer capable of work and who have no other provision.

As to the number of workmen in former times there is little information.

According to official accounts there were:

In the year	1665.....	280 men
" " "	1669.....	358 "
" " "	1747.....	450 "
" " "	1764.....	590 "

And in the years from 1786 to 1797 (at the time of the Spanish contract) there were over 900 miners employed. The number of workmen diminished from the year 1803 on to from 500 to 600 men, rose in 1860 to 700, and amounts now to over 1000 men.

At the State's Works at Idria only men are used and no women are employed. Work is begun at the age of fifteen years.

The present staff of lesser attendants, overseers and workmen is given in Table III.

There are permanent and temporary workmen. Permanent or regular workmen are such as are placed on the muster rolls and have all the privileges of workmen, who share in the commissary department and in the benevolent society (*Werksbruderkasse*), and have a right to provisions. The temporary or irregular workmen receive only cash wages and have no right to provisions, nor are they members of the benevolent society; they, however, make no contribution to it.

The hours of labor depend upon the occupation.

The miners and men at the works put in eight-hour shifts—all other workmen eleven-hour shifts—in the summer, and at least ten-hour shifts in the winter, an hour's rest being allowed at noon. The miners and men at the works are mostly paid by the piece, which is measured and paid by a regular scale of prices. The other workmen are paid by the shift, each kind of work having its proper price in the scale of wages.

The wages of the regular workmen consist partly in cash payments, partly in a "natural payment"—that is, in provisions. This latter consists in the gift of flour and grain, or maize, at a low, fixed price, which is placed at three florins, forty kreutzers, for a hectolitre of flour, and two florins, seventy kreutzers, for a hectolitre of corn or maize. The amount that may be taken varies, according as the workman is single and under twenty years, or single and over twenty years; and differs for married men and widowers, and is also different for married men and widowers, according to whether they have no children, or one, two, three, etc.; so that the more children a workman has under the normal age (twelve years for girls and fourteen years for boys), the more provisions he can call for. In consequence of this arrangement of a fixed price, the workman is not disturbed by the variations in the price of grain;

while, on the other hand, the mine, which furnishes the grain, suffers a loss in buying when grain is high, and makes a profit when it is low.

For storing the grain, which was formerly kept in the castle Gewerkenegg, a granary and material warehouse was built, in 1768 to 1770.

At present there are, in round numbers, 440 hectolitres of flour and 6,000 hectolitres of grain or maize, of a value of 70,000, to 80,000 florins, given out in this manner to regular workmen.

The natural wages—that is, the loss which the mine suffers in thus giving out grain and flour at a fixed price to the workmen—are, according to the price of grain, very different, and varied in the last decade between 20,000 and 45,000 florins per year.

The cash wages of the workmen amounted in the last years to 160,000 to 180,000 florins yearly.

The regular workmen have, in addition to the designated wages, a right:

1. To purchase wood for fuel and lumber for repairing their dwellings at a limited price.
2. To money in case of sickness.
3. To medical treatment and drugs, free of expense, in case of sickness.
4. To provision for their person in case they become incapable of service, and for their widows and children.
5. To the privileges of the coöperative society.

The following is to be added to the above:

(To 1.) Each regular workman who is married can purchase from the governmental woodyard 7 r. m. (volume metres) of wood fuel, or if he is single, 3.5 at a limited price of 61.5 kreutzer per cubic metre, while the purchasing price for the works is 2 florins 50 kr. The loss which the works suffer in furnishing fuel at these rates amounts yearly to 7000 to 8000 florins.

The lumber for repairing the houses of miners who have them is furnished there at half the cost price.

(To 2.) The money in case of sickness which the regular workman receives amounts, as a rule, to two-thirds the regular cash payment

for wages, and is paid from the third day of his sickness on, for each shift which the workman loses. The right to provisions also exists during sickness.

Irregular workmen have a right to sick wages only when they have been severely injured during their work.

The works pay out yearly as sick wages at present from 2500 to 3000 florins.

(To 3.) The mine has furnished medical attendance to the workmen from the earliest time.

Even as early as 1730 a surgeon was employed at the cost of the works, and in 1759 a doctor of medicine was established as physician of the works. The first physician of the mine was Anton Scopoli, the second Balthasar Hacquet, both of whom have secured for themselves names as authors.

At present the mine pays two physicians, both doctors of medicine.

All the regular workmen have a right to free treatment for themselves, their wives and children under normal age, and the irregular workmen also who are injured while in the performance of labor.

The workmen who have a right to be taken care of have their medicines furnished free. The works possess their own licensed drug store with an apothecary who is intrusted with the duty of furnishing the workmen with medicines at a reduced rate on the order of the physician. For care of sick and medicines the mine has spent, in the last years, 5400 to 5600 fl. yearly.

Particular care is given to the treatment and cure of those suffering from mercurial salivation.

The improvements in manipulation, which, in recent times, have been made on technico-economic grounds at the works, in order to avoid the loss of quicksilver fumes, had also the aim and the consequence of better protecting the workmen from breathing these and other fumes.

The workmen who clean the condensation tubes and condensation chambers are furnished with bacon to eat, as an antidote, at the cost of the works, and it is seen that they make use of the baths which are placed at the works, when they have finished their labors.

The foremen and others constantly engaged about the works are given an annual vacation of several weeks, their pay being continued, so that they may enjoy a change of air away from Idria. In order to avoid a longer exposure to the quicksilver fumes, there is a change of workmen every three months.

The sanitary relations are by no means unfavorable for the workmen engaged at the quicksilver work. From the work of Dr. Johann Hammerschmied, "The sanitary relations and the trade diseases of the workmen in the Imp. Mining, Metallurgical and Salt Works and Forestry." (*Wien. 1873, Im Commissions: Verlage bei Carl Gerolds Sohn*) may be seen p. 180, that the average rate for five years at Idria was, viz: for the miners, sick rate 67.86 per cent; death rate, 1.24 per cent; for the men at the works, sick rate 85.74 per cent; death rate 0.59 per cent, and that other industrial works show much larger rates of sickness and death.

In the year 1879, which, on account of the abnormal condition of the weather, may be placed among the unfavorable years for health, there occurred 734 cases of sickness among an average of 652 regular workmen, of which number 124 were mercurial. The latter consisted of Stomatitis mercurialis, Arthralgia and Myalgia mercurialis, Anæmia cum gastritide and Tremores; chronic mercurial poisoning was not observed. The average duration of sickness was twenty-four days. Of the 734 sick cases, twelve ended fatally, none, however, from mercurial sickness.

That the mine exerts itself actively and with success for the health of the workmen may be seen from the fact that in 1879 there were 163 former workmen on the pension list, of whom 68 per cent. were pensioned after having completed forty years' service in the works, and that of these pensioners, one was over ninety, seven between eighty and ninety, forty-six between seventy and eighty, and eighty-five between sixty and seventy years of age.

(To. 4.) The mine undertakes to provide for the old age of the regular workmen and their widows, as well as for the bringing up of their children under the normal age.

The pensions for men and their wives and the contributions towards bringing up the children are different, according to the pay of the workman and the class of his labor.

After forty years' service, the workman receives the full pension ; for less than forty years' service, the half pension.

All receive, besides a cash pension at the same time, the right to provision and fuel, the same as regular workmen.

In the last three years the mine has yearly given out to pensioners, according to the price of grain, from 32,000 to 40,000 fl., to 420 persons.

(To 5.) At the Idria mine a benevolent society has existed since the year 1737. This brotherhood does not have for its object, as other such organizations do, the assistance of the sick and aged among its members, because this is undertaken by the mine. The society gives only supplementary sick rates up to the full pay of the workmen in certain deserving or needful cases, and pensions, also, to those with only half pensions, as an additional help, and to such members who are not regularly entitled to a provision from the mine.

Besides, the society undertakes provision for its members and their dependents, by making contributions for spiritual and other matters. It also makes loans, to the amount of twenty florins, to regular workmen and pensioners, payable, without interest, in rates.

The society has property to the amount of 80,000 florins, partly in mortgages, partly in government bonds—in the latter, mostly.

In the investment of funds in mortgages, the members of the society who are householders have the first privilege of obtaining loans, the borrower certifying that he will return the principal in rates, within a greater or less number of years.

The society possesses, also, its own hospital and bath-house, in which its members are received and cared for free of charge, in case of sickness, and also have the use of warm baths. The regular workmen have deducted, monthly, three per cent. from the cash part of their salary and the profit they make from the commissary department, to pay for the privileges of membership. The yearly income of the society from interests amounts to 3,000 fl., and from dues to from 5,000 to 5,500 fl.

Since the increase of quicksilver production which has taken place in the last decade, there has been a lack of dwelling accommodations for the workmen, which the mine, for sanitary considerations, has endeavored to remove by building houses for the workmen; this is still being

done. At present the works possess twelve houses for assistants and for workmen, in which are lodged fifty-eight families, at a moderate rent.

The rest of the workmen live, for the most part, in houses which belong to the workmen or their connections. Of 401 houses in the town of Idria, thirty-eight belong to the mine, and of the remaining 363 houses, seventy-seven per cent. belong to the workmen, and only twenty-three per cent. to others not connected with the works.

Idria may in this respect be truly called a mining town, as three-fourths of its inhabitants are either connected with the works as workmen or pensioners, or as family connections, or dependents of these.

The mine also farms out 720 ares of tillable land, in small parcels, to miners, at moderate rates.

Also, the children of workmen, at the Imp. Public School, are furnished school books and other school necessities free of charge.

The overseers and smaller assistants of the mine, whose number at present amounts to thirty-six, receive only cash payments of 240 to 600 florins per year, together with dwelling houses (or yearly payments of thirty florins). The overseers at the works receive, besides, yearly production premiums.

The assistants and overseers do not have the privileges of the commissary department, but they are also members of the benevolent society.

In conclusion, there is yet to be stated the gross income of the works per workman—that is, each workman produced :

In 1870.....	1478 fl.
“ 1871.....	1493 “
“ 1872.....	1732 “
“ 1873.....	1728 “
“ 1874.....	2193 “
“ 1875.....	1617 “
“ 1876.....	971 “
“ 1877.....	865 “
“ 1878.....	994 “
“ 1879.....	784 “

In these figures are also mirrored the rise and fall of quicksilver prices.

## VIII.

### Administration.

*By M. V. Lipold.*

Soon after the undertaking of mining at Idria, the reigning prince, Emperor Maximilian I., appointed (1514) Wilhelm Neuman as mining judge (Bergrichter), who acted as judge in mining matters and exercised the imperial right of socage.

For conducting mining work each company had at first its own manager; the mining judge acted as inspector.

The mining at Idria, as of other mines of inner Austria, was under the Superior Mining Judicial Board at Obervellach, in Carinthia, which supervised the mining fiefs and the judicial business.

After the union of the entire mining operations by the Mining Regulations for Idria, in 1580, in addition to a mining judge, a manager (Verweser) and a bookkeeper were appointed by Archduke Carl for the conduction of mining operations; the mining work still remaining under the Superior Mining Board at Obervellach.

Franz Khisel was named as first Manager.

In 1689 the reigning Prince's mine at Idria received its own Mining Board with a Manager at its head, and in direct communication with the Exchequer at Vienna.

In 1747 there was set up at Idria a Superior Mining Board with a Mining Counsellor (Bergrath) as Director of Works, and with several assistant counselors. This was directly under the Exchequer at Vienna, and had also to manage the Prince's iron works at Sagor and Krain and at Tschubar in Croatia, as also the Kammeral-Herrschaft Gallenberg in Krain.

The mining at Idria during the occupation by the French was conducted by a Superior Mining Director. To Emperor Napoleon is due

the establishment of the Triple Order of the Golden Fleece. After the occupation, a Superior Mining Board again came into action, until in the year 1823 this was changed into a Mining Board with a Mining Counselor at the head, and was placed under the Superior Mining Board at Klagenfurt, and in the year 1850 under the Mining and Forestry Directory at Graz.

After the abolition of the latter in 1865, the Mining Board at Idria was placed directly under the General Directory of the State Possessions.

By decree of 29th November, 1868, the Mining Board of Idria was raised to an Imperial Mining Directory, with a Superior Mining Counsellor at the head, whose activity began with January 1st, 1869, and which was placed directly under the Ministry of Finance, but since 1872, it has been under the Ministry of Agriculture.

The superior officers of the State Mining Works at Idria, since the year 1580, are the following:

1580.....	Bergrath Franz Khisel
1600.....	Bergrath Georg Neiszl
1611.....	Bergrath F. Iggl v. Waldrekhürn
1614.....	Bergrath Stefan Muschilitsch
1617.....	Bergrath Matthias Mödring
1622.....	Bergrath Dr. Hannibal Bottoni
1627.....	Bergrath Barthol Pacher
1646.....	Bergrath Bernhard Prandi
1657.....	Bergrath Johann Naumann
1658.....	Bergrath Caspar v. Lichtenheim
1674.....	Bergrath Hanns v. Lichtenheim
1682.....	Bergrath Sigmund v. Kienbach
1690.....	Bergrath F. Stampfer v. Walchenberg
1716.....	Bergrath Leopold v. Litchtenturm
1724.....	Bergrath Anton v. Steinberg
1747.....	Bergrath Anton Hauptmann
1754.....	Bergrath Anton v. Sartori
1764.....	Bergrath Johann Graf Ignazi
1791.....	Bergrath Gottlieb v. Gerstorff

1798.....	Bergrath Josef v. Leitner
1806.....	Gubernialrath Emanuel Count v. Schärffenberg
1809.....	French Ober-Bergdirector M. Gallois
1813.....	Bergrath Leopold Edler v. Passetzky
1824.....	Bergrath Alois Prettnner
1838.....	Bergrath Franz Alberti
1849.....	Bergrath Rudolf Ritter v. Lichtenfels
1853.....	Bergrath Sigmund v. Helmreichen
1867.....	Bergrath Markus Vincenz Lipold

(Since 1869 Ober-Bergrath)

The officers of the works at the close of 1879 were the following :  
Director, Markus Vincenz Lipold, Superior Mining Counselor.

#### MINING.

Chief: Superior Mining Manager, Adolf Plaminek; Surveyor Romuald Illes.

#### METALLURGICAL AND VERMILION WORKS.

Chief: Mining Counselor, Josef Cermak; Assayer, Eduard Teuber;  
Manager of Works, Heinrich Langer; Foreman of Works, Carl Mitter.

#### BUILDINGS AND MACHINERY.

Chief: Building and Machinery Inspector, Johann Onderka, with  
the title of Mining Counselor.

#### TREASURY DEPARTMENT.

Chief: Cashier, Josef Carl v. Hohenbalken; Controller, Carl Max  
Hermann.

#### MATERIAL MANAGERS.

Chief: Material Manager, Wilhelm Leithe; Material Controller,  
Eduard Esterl.

#### DIRECTORY CHANCERY.

Chancery Officer, Franz Zazula.

#### SANITARY BOARD.

Mining Physician, Dr. Johann Baaz; Mining Physician, Dr. Carl  
Rauch.

## MINING STUDENTS.

Anton Edler von Posch and Theodor Sternberger.

The mine has during the last decade paid, in taxes and duties :

1870 .....	71,157 fl.
1871 .....	65,909 "
1872 .....	75,502 "
1873 .....	85,538 "
1874 .....	95,546 "
1875 .....	98,116 "
1876 .....	102,354 "
1877 .....	68,104 "
1878 .....	39,748 "
1879 .....	27,603 "

The salaries and emoluments of the Mining Directory took in the same time a sum of 19,900 florins annually.

The Imperial Mining Directory acts in the name of the Mining Bureau as patron of the town parish of Idria.

Already, in the year 1522, there was appointed a chaplain for the mine workmen, who first performed the service in the chapel on the castle hill, and then afterwards in the Holy Trinity Church, erected at that time.

The still-existing parsonage was built by the works in 1608. In the year 1628 the corner-stone of the Barbara Church, the present town church, was laid ; in 1638, the Holy Trinity Church was rebuilt ; in 1678 the corner-stone of the Antony Church was laid ; in 1736 to 1738 the Barbara Church was enlarged and the present church tower was arranged ; finally, in the year 1781, the Holy Cross Church was built.

In 1678 a benefice was founded by Freiherr v. Lichtenthurn for the care of souls, and a house was built for the beneficiate. This Lichtenthurn benefice still exists, and the beneficiate acts as religious teacher in the school.

The Idrian chaplaincy was, in the beginning, under the parish of Lower Idria, but became more and more independent of the mother parish, until, in 1700, a complete separation occurred, when Idria received its own chaplain, and the town of Idria received its own birth and marriage book.

In 1752 the chaplaincy of Idria was raised to a parish, and in 1817 to a deanery. It belonged, until the year 1792, to the diocese of the Archbishopric Görz, and was in this year incorporated in the Bishopric Laibach.

The clergy, except the beneficiate, are paid by the works, and the benevolent society furnishes a contribution of 400 florins for the chaplain.

The mine pays, also, the organist and sacristan; furnishes a miner as assistant to the sacristan, under the direction of the priest; furnishes, also, a yearly contribution of 676 florins for the needs of the church, and furnishes the necessary fuel for heating the vestry.

The outlay of the works for religious instruction and patronage amounts yearly to 2,500 florins in round numbers.

The Imp. Mining Directory interested itself, finally, in maintaining and overseeing the public school at the works.

Idria already possessed, in 1581, a school, and as the reformation had found entrance there, it had a Protestant teacher.

Afterwards, in consequence of the anti-reformation, the Protestant faith was supplanted, so that, in 1614, there were no supporters of this faith left in Idria, and the school was conducted by a Catholic teacher.

As under the Empress Maria Theresia the public schools were enlarged and improved, the mining town of Idria also received a main school of three classes and three teachers, with which, later, the Girls' Industrial School was combined, and at which instruction was given in music by means of a particular instructor.

At Idria there also existed, from 1784 to 1789, a gymnasium of three classes, and in 1853 there was added to the chief school a course of instruction in pedagogics (*Präparandie*).

Also, the mine undertook the care of the school, and provided for it one of the buildings at the works.

As the number of school children continually increased, the number of teachers was increased to four in the fiftieth and sixtieth years; a special class for girls was opened, and, on account of lack of room in the school building, parallel classes in other localities were started.

After the appearance of the new People's School Law, the mine at Idria, although not compelled to do so by law, undertook still further

the maintenance and expense of the school, which in 1873 was declared a private school with the privileges of a public school; so that the community of Idria was relieved from the legal necessity of erecting a public school.

The limitations of the then existing school accommodations made the building of a new structure for the school of the works necessary, which was done at the cost of the works, in the years 1875 to 1877, at an expense of 86,573 florins, the interior furnishing costing 6,778 florins more.

The instruction is at present given separately to boys and girls; and there are five classes of boys and four of girls, and a special industrial school for girls, in two divisions.

The five male and five female teachers are arranged in the ten grades required by the State Board, but their salaries are arranged according to a special rate, so that each teacher receives from 400 to 600 florins as a regular stipend, and certain additional sums of eighty to 120 florins for diligence, together with six quinquennial additions of forty florins.

For giving religious instruction to all the classes there is a remuneration set aside of 350 fl.; for musical instruction, 200 fl.

The management of the school is intrusted to the head teacher, who has the title of School Director. As such he receives a dwelling, rent free, and the addition to his salary of 150 florins.

The yearly outlay of the mine for the school of the works amounts to 7500 florins at present.

The Forests and Domains have stood under the management of the mine ever since the establishment of the mining district of Idria, while a separate Forest Manager (Forst or Wald Meister) was added to the Mining Court.

In 1873, however, the management of the forests was given over to the newly established Imperial Forest and Dominion Directory in Görz, and the management of the Idrian State forests, which cover 7862 hectares, is at present conducted by two Forest Managers under the designated directory.

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TABLE II.  
Statement of Production, Price and Profits  
OF THE  
GOVERNMENT QUICKSILVER MINE  
AT IDRIA, KRAIN.

Year.	Amount of Ore Treated.	Hg. Content.	Hg. Produc- tion.	Hg. Used for Vermilion.	Average Sell'g Price of Hg. per Metr. Cent.	Profit.	Loss.
	Metr. Cent. @ 100 kg.	Per Cent.	Metrical Centners @ 100 kg.		Austrian Gulden.		
1780	.....	.....	1260	....	...	.....	.....
1781	.....	.....	1260	....	...	.....	.....
1782	.....	.....	1260	....	...	.....	.....
1783	.....	.....	1260	....	...	.....	.....
1784	.....	.....	1260	....	...	.....	.....
1785	.....	.....	1261	....	...	.....	.....
1786	42,226	16	5836	....	...	.....	.....
1787	53,985	18	6771	....	...	.....	.....
1788	68,228	13	6786	....	...	.....	.....
1789	78,329	13	6739	....	...	.....	.....
1790	66,177	14	6142	....	...	.....	.....
1791	63,996	14	6283	....	...	.....	.....
1792	58,559	15	6496	....	...	.....	.....
1793	76,965	12	6519	....	...	.....	.....
1794	80,028	13	6808	....	...	.....	.....
1795	73,684	13	6470	....	...	.....	.....
1796	71,217	11	6380	....	...	.....	.....
1797	74,776	9	5603	....	...	.....	.....
1798	66,164	10	5881	....	...	.....	.....
1799	68,026	8	4061	....	...	.....	.....
1800	61,813	7	4020	....	...	.....	.....
1801	56,589	6	3421	205	263	.....	.....
1802	52,502	7	3698	863	263	.....	.....
1803	31,916	6	2063	961	263	.....	.....
1804	22,844	7	1723	935	266	.....	.....

Year.	Amount of Ore Treated.	Hg. Content.	Hg. Produc- tion.	Hg. Used for Vermilion.	Average Sell'g Price of Hg. per Metr. Cent.	Profit.	Loss.
	Metr. Cent. @ 100 kg.	Per Cent.	Metrical Centners @ 100 kg.		Austrian Gulden.		
1805	36,485	8	?	?	263	.....	.....
1806	25,023	8	?	?	?	.....	.....
1807	33,207	6	1922	?	385	.....	.....
1808	29,460	8	2115	947	491	.....	.....
1809	12,608	10	1616	451	452	.....	.....
1810	24,607	8	2097	?	?	.....	.....
1811	27,197	10	?	?	?	.....	.....
1812	29,364	9	2648	?	?	.....	.....
1813	21,236	9	?	?	?	.....	.....
1814	22,159	9	1774	205	?	499,528	.....
1815	18,901	11	1987	676	131	.....	456,592
1816	23,459	12	2881	634	?	396,738	.....
1817	23,352	8	1892	572	249	42,630	.....
1818	14,304	8	1043	1134	249	220,077	.....
1819	16,894	9	1424	537	228	445,170	.....
1820	18,552	7	1227	654	203	86,403	.....
1821	15,731	9	1257	535	218	2,158	.....
1822	15,353	9	1222	528	218	44,226	.....
1823	16,140	8	1198	553	188	70,018	.....
1824	18,045	9	1459	189	188	.....	53,745
1825	18,605	10	1773	653	188	234,743	.....
1826	34,158	5	1712	455	200	208,546	.....
1827	30,183	6	1544	680	208	125,689	.....
1828	28,135	6	1503	483	204	93,877	.....
1829	23,520	5	1510	538	173	38,453	.....
1830	25,710	5	1290	511	169	80,395	.....
1831	27,383	6	1732	457	169	106,983	.....
1832	26,301	6	1610	717	173	112,829	.....
1833	27,986	8	2157	669	195	238,817	.....
1834	27,957	7	1927	897	212	251,959	.....
1835	30,037	6	2050	562	323	453,489	.....
1836	41,657	4	1637	244	403	455,586	.....
1837	42,581	4	1802	420	408	680,542*	.....
1838	39,892	4	1407	513	408	294,057*	.....
1839	34,960	4	1611	594	413	746,193*	.....
1840	32,920	5	1504	621	427	382,297*	.....
1841	38,441	4	1441	704	427	380,613*	.....
1842	44,300	4	1624	814	327	445,236*	.....
1843	55,451	3	1519	417	444	421,975*	.....
1844	68,455	2	1665	531	471	507,446*	.....
1845	71,281	2	1796	460	472	483,448*	.....

Year	Amount of Mer. Cent. Treated	Hg. Content.	Hg. Produced	Hg. Used for Vermilion.	Average Selling Price of Hg. per Metr. Cent.	Profit	Loss.
	Metr. Cent. @ 100 kg.	Per Cent.	Metrical Centners @ 100 kg.		Austrian Gulden.		
1846	71,825	2	1529	592	470	375,290*	.....
1847	77,691	2	1548	499	472	184,020	.....
1848	77,274	2	1608	632	446	507,948	.....
1849	86,869	2	1399	828	419	272,711	.....
1850	145,217	2	1415	523	455	832,704	.....
1851	187,888	1	1412	539	463	502,083	.....
1852	171,996	1	1410	730	388	44,179	.....
1853	123,420	1.9	1521	742	267	340,277	.....
1854	178,351	1.4	1405	722	270	219,743	.....
1855	196,943	1.7	1534	660	246	257,648	.....
1856	153,010	1.7	2047	1180	200	305,690	.....
1857	151,461	1.9	3170	1384	200	357,754	.....
1858	192,499	2.2	1717	204	216	89,239	.....
1859	168,023	1.9	2843	1420	212	256,056	.....
1860	196,888	2.2	1663	781	254	224,082	.....
1861	174,446	1.5	2240	755	281	853,544†	.....
1862	166,800	1.9	1626	861	280	71,458	.....
1863	139,958	1.5	2428	967	221	.....	86,500
1864	153,130	2.1	2306	649	246	487,162	.....
1865	184,243	1.9	1693	1008	246	106,045	.....
1866	228,472	1.5	1838	919	241	81,985	.....
1867	190,653	2	2598	1009	229	624,112	.....
1868	234,345	2	2847	1060	220	372,895	.....
1869	274,245	2.53	3167	891	220	474,296	.....
1870	266,920	2.2	3707	988	270	692,216	.....
1871	291,376	2	3738	336	331	1,079,092	.....
1872	293,222	1.9	3835	665	348	781,295	.....
1873	268,305	1.69	3774	470	430	1,305,145	.....
1874	264,956	1.43	3721	480	639	1,971,936	.....
1875	294,663	1.47	3697	581	394	967,812	.....
1876	277,420	1.534	3724	493	290	591,409	.....
1877	333,114	1.371	3802	440	248	357,051	.....
1878	339,941	1.360	3589	745	224	52,176‡	.....
1879	406,266	1.076	4193	505	290	357,198	.....

\* The large profit during these years resulted from the high price of the raw material at this time.

† The large profit during this year came from the 255,000 d. worth of quicksilver obtained in tearing down the Francisci furnace.

‡ In the quicksilver production of the years 1863 to 1878 are also included 966 metrical centners of quicksilver, which were obtained by tearing down the Leopoldi furnaces and two shaft furnaces, and by digging up the foundations of these furnaces and the Hahner and Franz furnaces, and which had a value of 321,000 florins.

§ The small profit for this year lay in the fact that the selling expenses for the ten years previous, amounting to 104,922 florins, was paid during this year.

TABLE III.

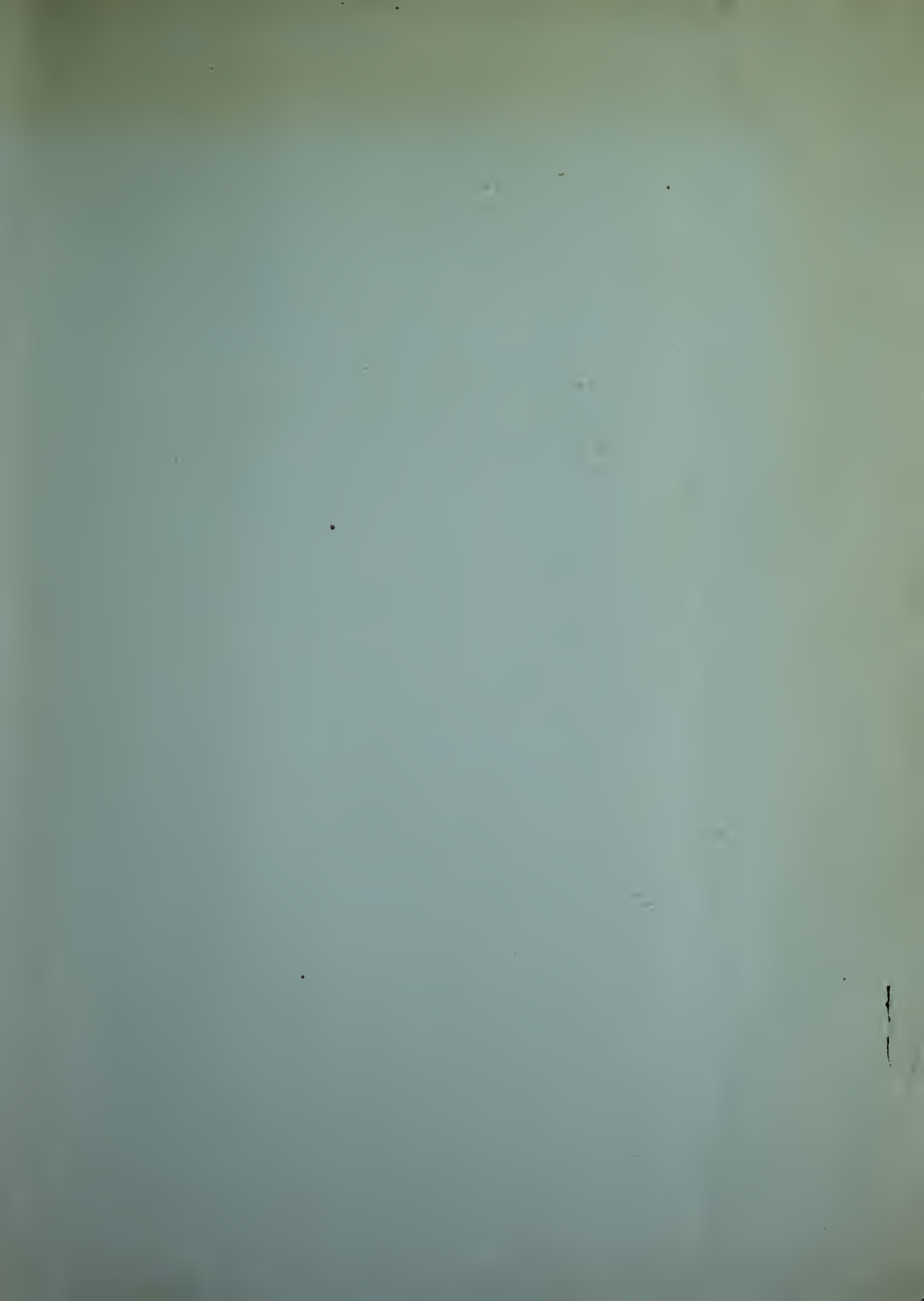
## EMPLOYEES AT IDRIA IN 1880.

Class.	Number.	Totals.
A.—Mine and Ore Dressing.....		680
Mine tool inspectors.....	2	
Assistants to do.....	5	
Shaft masters.....	2	
Overseer at hydraulic engines.....	3	
Mine clerk.....	1	
Mine master mason.....	1	
Powder men.....	2	
Miners, timbermen, mine masons, tunnel guards, fire watchers.....	298	
Shaftmen and brakemen.....	51	
Car-men.....	85	
Clear-up men (apprentices).....	84	
Sorting house foreman.....	1	
Ore sorters.....	8	
Intermittent mine laborers.....	97	
"     sorters (boys).....	40	
B.—Works, Factory and Assay Laboratory.....		208
Tool inspectors at works.....	3	
Foremen at works.....	5	
Clerk of works and overseer of factory.....	1	
Watchmen at works.....	4	
Chief firemen.....	35	
Firemen.....	70	
Car-men and chargers.....	66	
Engineer, brakesman, and Aufschneider.....	3	
Workmen in vermilion factory.....	10	

Class.	Number.	Totals.
Assistant in assay laboratory.....	1	
Assay sample stampers.....	2	
“ “ takers.....	2	
Intermittent laborers at works.....	6	
C.—Buildings, Machinery, Communication.....		124
Chief engineer.....	1	
Engineers.....	12	
Ditch watchman.....	1	
Chief smith.....	1	
Smith foreman.....	1	
Locksmiths.....	2	
Mine smith.....	1	
Machine smiths.....	3	
“ “ helpers.....	1	
Smiths.....	5	
Hammer-men.....	3	
Smith apprentices.....	3	
Overseer and accountant.....	1	
Master carpenter.....	1	
Cabinet makers.....	11	
Road overseer.....	1	
Drivers.....	3	
Intermittent smiths.....	13	
“ carpenters.....	26	
“ hod-carriers.....	22	
“ brick-layers.....	12	
D.—Miscellaneous.....		12
Porter and chancery servant.....	1	
Mining directory clerk.....	1	
Treasury clerk.....	1	
Material department clerk.....	1	
Overseer of product warehouse.....	1	

Class.	Number.	Totals.
Fachin.....	I	
Castle watchmen.....	3	
School servant.....	I	
Organist and sacristan.....	I	
Sacristan's assistant.....	I	
Total.....		<hr/> 1024





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